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HEALDS AND REEDS FOR WEAVING

SETTS AND PORTERS

BY

T. WOODHOUSE

DUNDEE TECHNICAL COLLEGE AND SCHOOL OF ART

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PREFACE

THIS little volume deals exclusively with healds and eeds for weaving, and the calculations which are of so nuch importance in regard to the setts and porters of abrics.

In all there are fifteen different methods of counting iealds and reeds considered, and the principle involved n the conversion of each method to all the others is explained by examples in the text, by tables and by a chart.

So far as the author is aware the present treatise, which ippeared originally in *The Textile Manufacturer*, is the only one of its kind, and hence it might fill up a gap in modern extile literature.

T. WOODHOUSE.

January 1920.

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HEALDS AND REEDS FOR WEAVING

SETTS AND PORTERS

CHAPTER I

DESCRIPTION OF HEALDS AND METHODS OF MANUFACTURE

In all actual weaving operations for simple fabrics, and for most of the elementary types of ornamental fabrics, it is the invariable custom to use the above-mentioned articles in conjunction with the various mechanical or equivalent devices for the separation of the threads of the warp. After the warp has been beamed, dressed, or slashed on to the weaver's beam, the threads, of which the warp is composed, are drawn, first through the eyes or mails of the heald, and then through the openings between the wires of the reed.

It will be found convenient to deal with the two distinct articles separately, and in the order in which they are used in the preparation of the warp for the loom; afterwards the two will be considered jointly with regard to the effect which they have upon the proximity of the warp threads to each other.

Figs. 1 to 5 illustrate the different parts which are required for the construction of what we have termed "healds"; they also show the relation between the constituent parts. Different names are given in different

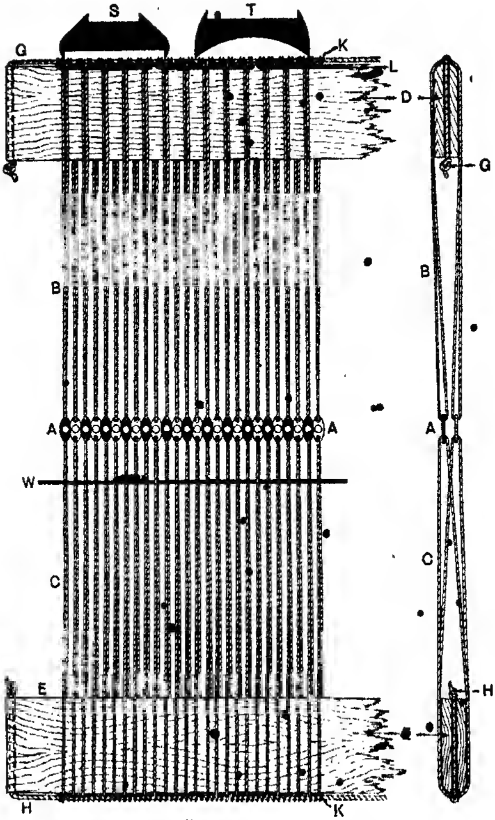


FIG. 1.

FIG. 2.

FIG. 1.—Front view of heald and counting gauges.
FIG. 2.—End view of heald.

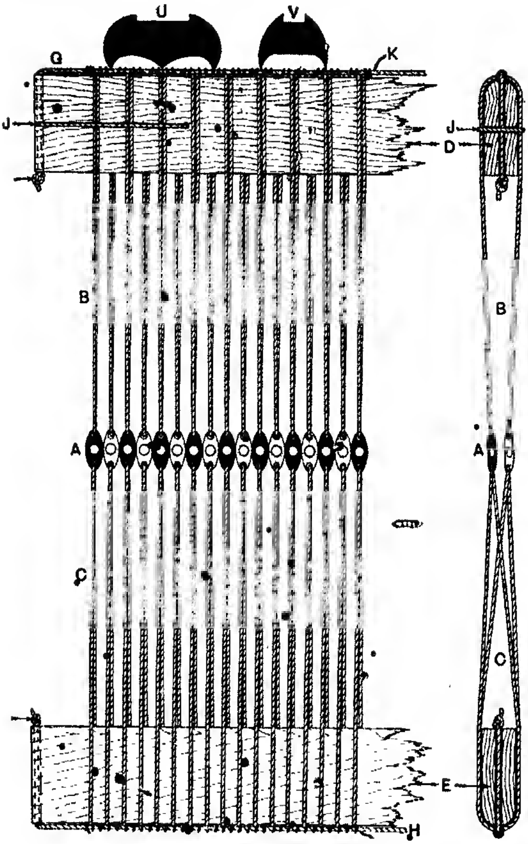


FIG. 3. FIG. 4.

FIG. 3.—Front view of coarse heald and counting gauges.
FIG. 4.—End view of coarse heald.

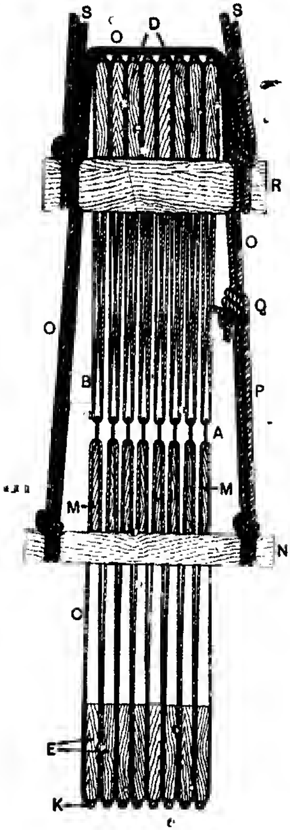


FIG. 5.—Group of healds ready for drawing-in operation.

districts to indicate these articles. Thus, healds, heddles, gears, cambs, leaves of the caulm (harnesses in America), and other names, are used to distinguish a complete set of the articles which form one group—say, for example, the group illustrated in Fig. 5, which is an end view of eight separate parts, and each of these parts is identical with Figs. 1 and 2, or Figs. 3 and 4, and is known as a shaft, stave, or leaf.

Except for certain types of primitive looms, the minimum number of leaves in a set or group is two, but it is well known that a group may contain any desirable or necessary number up to the maximum which is capable of being operated in any particular loom, and different types of looms are constructed to accommodate different numbers of leaves, according to the class of work for which the loom in question is built.

Separate views of portions of two kinds of leaves, or, rather, modifications of the same kind, appear in the above figures. Thus: Figs. 1 and 3 are front elevations; whilst Figs. 2 and 4 are end elevations.

In practice, each leaf is a little wider than the actual width required for the warp threads in the loom, and, since there are all widths of cloth between the limits of the very narrow tapes and the very wide fabrics, it follows that there is no constant length or width of such leaves. All leaves, however, which belong to one group are of the same width, and each leaf is composed of a few distinct parts, which are distinguished from each other in Figs. 1 to 5 as follows: A is the heddle or mail, usually made of steel, occasionally of brass, and sometimes of glass. The steel mails are much cheaper and harder than the brass ones, while the glass ones are used for special work where extreme smoothness is desired. B is the upper heald twine, while C is the lower heald twine, and both those are almost invariably made of cotton twist for

the ordinary kind of healds, although fine steel wire is now used extensively to form, in one piece, parts A, B, and C, while in other cases the same three parts are made entirely of cotton. Thirty to forty years ago worsted was used extensively for heald twine, and silk yarns were also employed. D is the upper shaft, stave, or lath; and E is the lower lath.

In all cases the warp threads, F, Fig. 6, are passed through the central eye of the mail A, as illustrated,

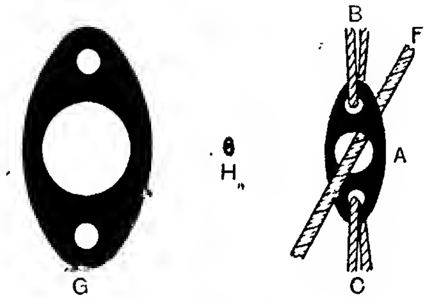


FIG. 6.—Large, small and medium mails with warp thread in position.

if the mail contains three eyes. This figure illustrates, in actual sizes, the largest and smallest mails, G, H, which the author has seen. The small mail H contains two holes only; whereas most other mails contain three. Sometimes two threads, or even more, are passed through the same eye of the mail; this method is feasible and economical when the threads work in pairs, or larger groups, and it is not absolutely essential that all the threads in such group of two or more should remain perfectly parallel to each other.

In all the figures it will be seen that the upper and

lower holes in the mails A are utilised respectively for the upper and lower heald twines B and C. When one considers the great diversity of textile fabrics, one is not surprised to find that there are scores of different sizes and shapes of mails. Several varieties are illustrated in Figs. 7 and 8, all representing metal mails. A considerable number of glass mails are also made, several varieties of which are illustrated in Fig. 9. The upper row in this figure shows that several types are made with provision for controlling two or more threads in each mail; these particular types are called "decked mails."

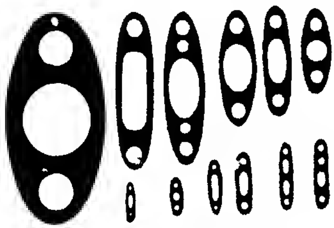


FIG. 7.—Group of mails of different kinds.

The size of the eye and the size of the mail as a whole are chosen to suit the particular class or grade of texture which is to be made, and the thickness of the yarn which the mail is intended to control. It will, therefore, be understood that while the illustrations Figs. 1 to 4 show two sizes only of the same shape of mail, there are many intermediate sizes in actual use. It is quite obvious that, since all textile threads contain knots, and most of the threads in addition have other parts that are thicker than the normal thickness of the thread, the eye of the mail must be big enough to let the knots and the enlarged parts pass through freely during the weaving process.

The wide range of mails is accompanied by a wide range of heald twine, for it is quite clear that the twine

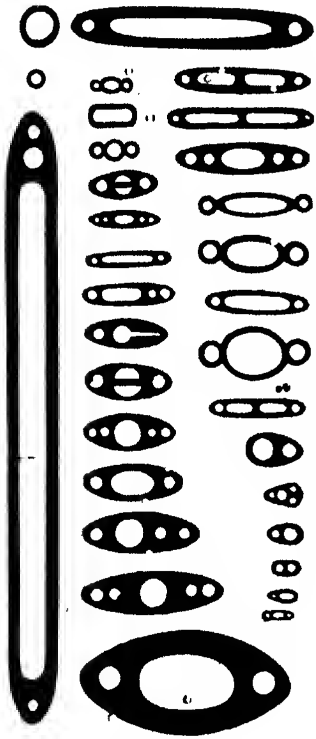


Fig. 8.—Group of mails of different kinds.

which is suitable for the very small mail H in Fig. 6 would be inadequate for the large mail G in the same figure, and that the types of twine which were satisfactory

for these two extremes would not be fit for many of the intermediate sizes. One size or thickness of twine, however, may be satisfactory for several sizes of mails, although it is not usual to stick closely even to the same thickness of heald twine for all healds composed of the same size of mail and containing the same number of mails per inch or other given measure. Different managers have different opinions as to the most suitable sizes of yarns for any given kind of healds to be used for the weaving of the same class of cloth. Thus, some managers prefer to use comparatively small twine, and to replace the healds

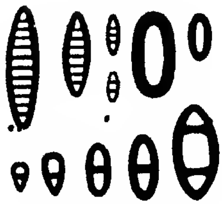


FIG. 9.—Group of mails of different kinds.

completely with new ones when those in use begin to wear and break. Other managers prefer to have a thicker and more expensive twine made from more plies of the same count of cotton, and knitted to the same size of mail, and for the same sett or porter of heald. When the latter method is adopted, it is usual to resort largely to repairs when the healds show signs of wear. Both these methods obtain even in connection with the simplest type of work where changes are seldom resorted to, and where the new warps are usually tied or twisted to the old warps. When the custom is to draw-in all warps, it is the invariable practice to see to all repairs before the operation of drawing-in is commenced.

In general, however, the final choice of the size of heald twine is left to the heald knitter, whose usually long and varied experience enables him to select a size which is invariably suitable for the particular number of mails per unit space. It is possible, however, to select numbers or counts of heald twine for different setts or porters, and counts which would give satisfactory results in practice; but so long as the heald-knitter has to meet the varied wishes of managers, the present methods will continue.

Whatever count of cotton twine is used, however, it is essential that the finished heald twine should be uniform in thickness and moderately strong; hence, such twine is invariably composed of several fine threads twisted together, either as an ordinary compound thread, or as a cable cord, either of which results in the production of a twine which is uniform in thickness and in strength.

The counts of the single yarns vary from 30's to 90's, and it is natural to expect that the finer counts will be used for the twines which make up the finer setts or porters. No fewer than 84 single threads of about 32's cotton are twisted together for the heald twine to be used in conjunction with the large mail G, illustrated in Fig. 6. It is a cable cord; 21 single threads are twisted together, and then four of these compound twists are twisted to make the cable cord, the structure being represented as 4/21/32's. The twine for the small mail in Fig. 6 would probably be made from silk twist of two or three threads.

Some heald-knitters use 30's or 32's for all kinds from 36-fold to 48-fold, and 36's or 40's cotton of various plies for the finer twines. It is seldom that less than 12 single threads are used to form a twine; 12/36's or 12/40's is often used for the finest of certain grades, and 12/90's for the finest of other types, and often cable twist.

The number of plies is often changed when different thicknesses of warp are woven, even if the number of

threads per inch is the same. Thus while 12/40's heald twine may be used for weaving one count of warp, 16/40's heald twine may be used for weaving another count.

No attempt is to be made in this work to describe fully the ingenious types of heald-knitting machines, but it will certainly be an advantage to describe briefly the method of making such healds as are illustrated in Figs. 1 to 5. In the first place, it should be mentioned that, as a general rule, the metal mails occupy more space than those which are made exclusively from cotton, such as those which are used extensively in the cotton trade, and, in addition, they are more expensive. Since much space is occupied by the above mails, it is sometimes advisable to use a mail of a different shape from those illustrated in Figs. 1 and 3. The eye is made a little deeper and narrower, as shown in certain of the mails illustrated in Figs 7 and 8. But whatever kind of mail is used for the ordinary healds, it is customary so to arrange the knitting that the mails of each leaf are arranged in two rows, as exemplified in Figs. 2 and 4. Fig. 4 shows the actual position, where the mails are in reality the same size and shape as those in Fig. 3, but turned partially round. Such an arrangement clearly makes provision for more mails, and therefore more threads, than would be the case if all the mails were in the same line.

The front row of mails in Figs. 1 to 4 is represented by the black figures, whereas the back row of mails on the same leaf is represented by the stippled figures. It need hardly be said that this difference is introduced solely for the sake of ready distinction in the drawings, and that in the real article all are exactly the same.

Both the upper cords B from each black mail pass to the front of the laths D, whereas both the upper cords of each stippled mail pass to the back of the

same lath. On the other hand, all the lower cords C from both sets of mails pass in the same order over the lath E, one in front and one behind. It is this method of knitting, or of arranging the cords, which enables the mails to be arranged in two rows, as shown in Figs. 2 and 4, and at the same time to secure satisfactory conditions in other respects. It will, of course, be understood that the laths D and E are introduced into their places after the heald is knitted, and the heald kept in its proper position by inserting the "leading band" or twines G and H into the slots as illustrated. An additional cord J, Fig. 3, is usually introduced at each end of both laths as indicated, to aid in keeping the heald in its proper position.

These slots are purposely omitted in Fig. 5, but in practice they are introduced into all.

The mails last much longer than the heald twine, and it is the practice to cut the mails from the worn-out healds, to destroy the remnants of cords, and to polish up the mails in a barrel or similar receptacle by oscillating the latter by machinery. These repolished mails, or new ones, are picked or threaded by hand on to a wire. A girl gets a handful of the mails and picks them out haphazard by means of a wire or thin iron rod. She then withdraws a number from the wire and places them between the first and second fingers, another lot withdrawn and placed between the second and third fingers, and a further lot between the first finger and the thumb. The three rows of mails are then arranged as regularly as possible, and a needle and cord is threaded through the upper small eyes of all the mails. Finally, the mails are allowed to slide down the cord which has been drawn through by the needle, and a knot at the end of the cord keeps all intact ready for the knitting machine.

These mails are then threaded or passed on to the mail

rod or guide at the feed end of the heald-knitting machine, the mail guide passing through the central eye, and the mail kept in a horizontal position. Two bobbins of the necessary size of heald twine are supported near the same end of the machine, and the twines from the two bobbins are threaded through the small holes of the mails and carried forward to the actual knitting apparatus.

During the process of knitting, each mail in succession is detached from the group and carried forward by selecting and conveying fingers, acting in guides, towards the last knitted mail. Two carriers, one on each side, take

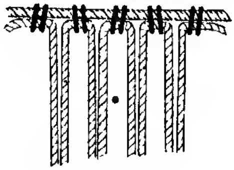


FIG. 10.—Enlarged view of heald cords.

hold of the two twines immediately behind the transported mail, and draw them in opposite directions to the extremities of the depth of the leaves—that is, to the top and bottom "leading cords" or twines G and H (the heald or leaf is horizontal during the knitting process), and this depth is determined by the size of the shed required in the loom, and to some extent by the number of leaves employed in the group. It is unnecessary to say more about this at present, except that the usual depths are from 10 in. to 18 in. over all. All the leaves in Figs. 1 to 5 are drawn 13½ in. over all.

While the two heald twines are close to the leading cords, and in the slots of two rotating wheels provided with bobbins of tarred twine, the wheels carry the bobbins

of tarred twine K twice round the leading cords, and also around the two lengths of heald twine which for the moment are held by the wheels parallel to the leading cords G and H, as illustrated on a larger scale in Fig. 10. The twine carriers then return towards the centre to pick up and carry away two further lengths of twine, B and C, from behind the next mail, which has in turn been brought to the knitting position by the fingers. After every ten mails have been knitted in coarse healds, 20 mails in fine healds, a cord L, Fig. 1, is automatically knitted in at the top to facilitate the counting of half beers or half porters, provided the beer or porter contains 40 threads: but any other suitable number can be arranged for if desired.

Two metal-pointed guide laths receive the twines B and C as they are knitted. Both laths are operated from below by cams. One cam raises its lath so that the double twines B may pass alternately over and under the lath, and thus form the order for the upper part of the leaf. The other cam raises its lath twice as often in order that the twines C may be disposed singly and alternately under and over the lath for the order shown at the bottom of the leaf.

CHAPTER II

DRAWING-IN AND REEDING OPERATIONS

In addition to the necessary condition of forming two rows of mails, as exemplified in Figs. 2 and 4, the disposition of the twines as just described facilitates the insertion of thin laths M, Fig. 5, when a large number of leaves are required in the same group, and also in groups of 4 when two threads are drawn at the same time by a double drawing-hook. These thin laths M are first entered between the twines C of the single knitting by turning the heald lath E horizontal; this clearly gives more room for the lath M to be entered. After a lath M has been entered for each leaf, the thin laths M are raised until their upper blunt but rounded edges come into contact with the mails A. These mails A are all shown black in Fig. 5, because it is assumed that in every leaf the first double cord is at the front, as shown in Figs. 1 and 3.

All the thin laths M are supported in this high position by means of two wooden bars N—one at each end—say, an old dobby lag, and two adjustable cords O and P from each lag. The lower cord O passes from one end of the lag N over the tops of the healds, and is then joined by a sliding noose Q to the shorter cord P which is naturally attached to the other end of the lag N. When the group contains a large number of leaves, and particularly for fancy drafts, the upper edges of some of the laths M are coloured, in order to enable the drawer-in to select, with

a high degree of certainty, an eye on any particular leaf. It is also a common practice to introduce thin pieces of wood or other suitable material between the laths M so that the mails will move on easily when selected by the drawing-in hook.

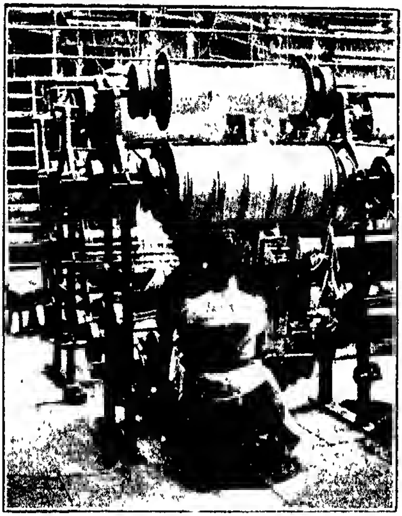


FIG. 11.—Girls drawing in warp threads into healds.

Two further but stronger rods R—one at each end—and the ropes S support the group of healds. These latter cords are usually attached to the ropes which support the warp beam above the healds while the operation of drawing-in the threads is proceeding.

In many cases special iron frames or beam stands are sued to serve as receptacles for empty and full beams,

and also to be utilised instead of the above-mentioned heavy ropes. These are illustrated in Fig. 11 with a full beam in position, and the two girls engaged in the

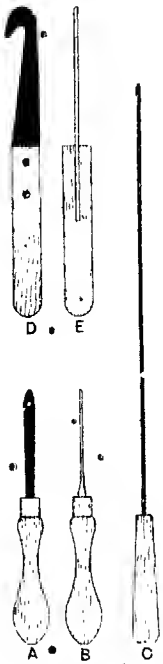


FIG. 12. Heald and reed hooks.

drawing-in and reeding operations. The girl nearest the observer draws in the threads, while the younger girl behind—termed a "giver-in" or "reacher in"—holds a group of threads near their ends to prevent entanglement,

and selects the threads in regular order from the lease-rods or the clasp-rods and holds them in a convenient position to be caught by the hook when the latter is being drawn through the eye of the mail by the drawer-in.

For plain and twill fabrics, the draft of the healds is 1, 3, 2, 4, and two threads are often drawn in at the same time. If the number of the healds in the group is small, and if the healds are made entirely of cotton—*i.e.* knitted eyes instead of metal mails,—and if the threads of the warp are drawn in singly, a drawing-in hook similar to that illustrated at A and B, Fig. 12, is used. But if a large number of leaves are required, and metal mails used, it is necessary to have a longer hook, such as that shown at C. This is simply about $\frac{1}{16}$ in. wire, filed flat near the end, and doubled over so that the hook will leave the eye freely without catching the sides of the mail. If, however, a double hook is used for drawing two threads at a time through separate mails on different leaves, as mentioned above, two hooks are inserted into the same handle, the ends of the hooks from $\frac{1}{4}$ in. to $\frac{3}{8}$ in. apart, and the eye of one hook about $\frac{1}{2}$ in. farther out than the eye of the shorter hook.

The threads are then drawn between the wires of the reed (to be described later) by means of a reed hook, usually a little coarser than the drawing-in hook at A, although this hook will serve the purpose. A reed hook of a coarser type is illustrated at D and E, Fig. 12, and modifications of this type are made to suit the different degrees of fineness of work. It is quite obvious that a reed hook made from $\frac{1}{16}$-in. flat iron would be quite unsuitable for use on a reed with many more splits per inch than 16, although the wires will yield.

For plain and twill work it is a very common practice to draw the threads through the reed as each lot is drawn through the healds. Thus, if two threads are drawn

through the mails or eyes of leaves 1 and 3, they are immediately drawn through an opening in the reed; then two threads are drawn through the eyes of leaves 2 and 4, and these in turn are drawn through the next opening or split of the reed, and so on until every gait of the leaves is drawn. In Fig. 11 the operation of drawing-in

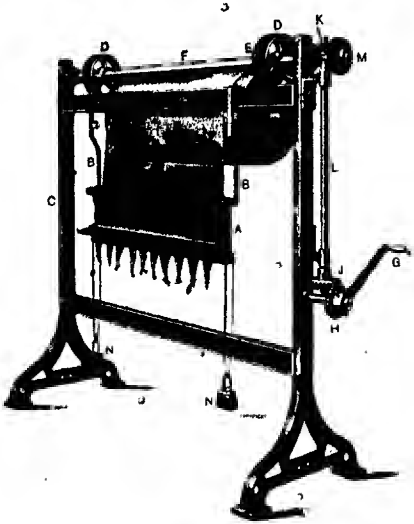


FIG. 13.—Drawing-in frame.

and reeding is taking place at the same time, but probably with a single hook, as at A, Fig. 12, and the double operation is proceeding from right to left, and not from left to right, as obtains when laths such as those at M, Fig. 5, are used.

In some of the modern drawing-in and reeding frames, such as that illustrated in Fig. 13, the healds A are

supported by two iron hangers B, which in turn are supported by the upper cross-rail of the frame, and on which they may be adjusted for all widths of leaves up to the maximum width of the frame; the cross-rails are fixed to the vertical frames C. The warp beam is hung on two curved iron bands secured to two straps D; the straps D are attached to two pulleys E on the shaft F. The raising and lowering of the beam by means of the straps D and the pulleys E is accomplished by the handle G, bevel-wheels H and J, worm K on shaft L, and worm-wheel M on the shaft F. In all cases ropes are hung on the ends of the bottom laths, and weights N, attached to these ropes, keep the healds steady.

CHAPTER III

HEALD CALCULATIONS: CASTING-OUT OR FILEYING

THERE are just two other points to be noted in connection with Figs. 1 and 3. First, the four gauges or measures in solid black, S, T, U, and V, above the "leading bands," and second, the dark line W in Fig. 1, which is shown as passing in front of nine heald twines and behind one, and this order is repeated for every ten healds, The four gauges, S, T, U, and V, will be referred to later when the methods of counting reeds are discussed and explained.

The dark line W, Fig. 1, simply represents a cord which may be introduced in any desired order—in the illustration every tenth—to call the attention of the drawer-in to the fact that some of the mails are to be neglected or left empty. The cord W usually occupies a position immediately in front of the first lath M, Fig. 5, say about one inch below the mails, when such laths are used in the process. The cord extends right across the front heald, and is attached at both ends to the cords O, or to any other suitable article—perhaps to the surplus healds near the two ends of the leaf. When the healds are drawn from right to left, as illustrated in Fig. 11, the laths M are not used; the drawer-in picks the healds in succession from the lower cords C—a group of which she holds in her left hand—either with the fingers of her right hand or with the drawing-in hook which she holds in her right hand. Hence for such a method a cord

W in the position indicated in Fig. 1 would obstruct the process of selecting the cords. A more convenient place for the cord W, if it is found necessary to use one at all in simple cases, would be somewhere above the mails A.

It need hardly be said that each heald or leaf is knitted according to the maximum number of threads which the leaf is destined to control; any smaller number of threads per unit width can be operated by leaving idle or empty the number represented by the difference between the above maximum number on each leaf and the number required to be in use on that leaf for the cloth. The same result will clearly obtain if, at the places where the mails are indicated to be left empty, a thread is drawn through two mails instead of one.

The cord W, Fig. 1, indicates that every tenth cord on that leaf, and on all the other leaves in the group, if they are of the same "sett" or "porter," and if the draft requires the same number of threads on each leaf, should be left empty; or that when this cord is reached, the drawer-in should draw doubles for one gait—that is, two mails should be taken for each thread at that point on each of the individual leaves employed. In many parts of England the technical term for this process is "casting-out," while in Scotland the same process is known by the name of "fileying."

Although the number of mails in a given width may vary, as is indicated in Figs. 1 and 3—these two contain respectively approximately 5 and $3\frac{1}{8}$ mails per inch—it is usual, for the ordinary type of healds, to have the same number of mails per inch on each leaf. But when the healds are required for certain types of both single and compounds fabrics, and for more or less decorative stripe designs, the above conditions are often departed from.

Thus it may happen that, say, 6 leaves are required for the face threads of a double cloth, and 6 leaves for the back threads, or 12 leaves in all, and that there are two threads

of face warp to one thread of back warp. In this case each of the 6 leaves for the face threads would contain twice as many mails as each of the 6 leaves for the back threads. This arrangement would simply mean that two groups of healds of different setts and 6 healds in each group would be ordered, but every leaf in the same group would contain the same number of mails. If, with the same 2 to 1 distribution of face and back threads, there were 12 leaves for the face threads and 6 leaves for the back threads, every leaf in the group of 18 would contain the same number of mails.

Suppose, however, that every leaf, or nearly every leaf, required a different number, and that while a few mails per inch were required in some leaves, others required only one mail per inch, and odd leaves even less than one per inch somewhat as illustrated in Fig. 14. It may then be desirable to have the necessary number of leaves in the group knitted according to the draft, so that every mail shall be occupied, and each one, or group of more than one, shall appear in its proper place according to the arrangement of the threads in the draft in Fig. 14. It is obvious that an equivalent spacing of the mails could be obtained if every leaf contained the same number of mails, and a suitable method of casting-out or of drawing double eyes be employed. Nevertheless, in fancy weaving of this kind, and indeed of any kind, the possibility of wrong drafts is at a minimum when there are no idle mails on the leaves.

Again, the method of casting-out or fileying would be quite unsuitable, or rather undesirable, in those leaves which are used for the weaving of dice patterns and the like. Consider, for example, one of the simplest cases in which 8 leaves are employed: 24 threads of the cloth to be controlled by leaves 1 to 4; the next 24 threads to be controlled by leaves 5 to 8, and so on, as illustrated by the

draft in Fig. 15. The most satisfactory way for such is to have 24 mails alternating with a gap equivalent to 24 mails on leaves 1 to 4; and a similar gap alternating with 24 mails on leaves 5 to 8. Then the threads in each group of 4 leaves would have more freedom of movement, and would work with less friction than would be the case if the threads in one group had to rise and fall amongst the empty mails and cords in the other group of 4, and *vice versâ*.

When healds are knitted in this way they are said to be "spaced" or knitted to the draft. Other methods will be mentioned shortly. Several types of striped patterns and spot patterns, in which the "sett" or "porter" varies in different parts, or in which the sett is constant but in which various sections are woven by different groups of leaves, are woven under the best conditions when the healds are spaced according to the disposition of the threads in the draft.

During the knitting process the operation of knitting takes place as desired at those places where mails are required, but for the blank or missed parts the carriers are prevented from acting, and the bobbins simply rotate round the two "leading bands" until the desired distance between the knitted portions has been passed over. Thus, in the case of the draft in Fig. 15, the machine would operate as under:—

Leaves 1 to 4: knit 24, miss 24 } repeat for width required.
" 5 " 8: miss 24, knit 24 }

Sliding heddles or healds are often utilised for this class of work.

Whatever type of knitting is adopted in the manufacture of cotton healds, it is necessary to submit each completed heald to some process which will increase the life of the twine at those places which are subject to the most wear and tear. This process invariably consists of sizing, varnishing and drying. In some cases the healds are oiled before they

are varnished. After the healds have been sized they are varnished, and the even spreading of the varnish, or of the oil and varnish, is done by rotating brushes which move vertically against the leaf while the latter, in a vertical position, is carried horizontally to and fro between the rotating brushes. The leaf is then removed and placed on a stand ready for being conveyed to the store-room to be dried. The varnished part usually extends to within about two inches of the top and the bottom of the leaf, so that the only unvarnished parts are those which cover the laths D and E, Figs. 1 to 5. The various operations after the leaf leaves the knitting machine include three to six individual operations of stove drying.

When there is a considerable number of leaves to be used in the loom, there is the additional chance of the cord or twine which is over the laths wearing on account of the friction caused as they pass and repass each other during the operation of shedding; when this danger exists it is usual to varnish every part of the leaf, and, besides, it is often necessary to insert leather or similar bands at both ends of each leaf to keep the heald twines apart.

No definition of "sett" or "porter" or "portie," has been introduced yet into this work, and it is unnecessary to define them until the reeds are considered. The calculations referring to the healds can be performed without reference to any particular method of counting the "sett," for they simply involve proportionate numbers.

If the number of threads in the loom reed is stated as so many threads per inch, and if each leaf controls the same number of mails in any simple and regular order—*e.g.* plain draft, straight draft, and the like,—the number on each leaf is obviously as under:—

$$\frac{\text{Threads per inch in reed}}{\text{Number of leaves}} = \text{mails per inch on each leaf};$$

and—

$$\frac{\text{Total threads in the warp}}{\text{Number of leaves}} = \text{total number of mails in use on each leaf.}$$

If the word "sett," or "porter," or "portie," is used instead of threads per inch; then—

$$\frac{\text{Sett or porter of cloth}}{\text{Number of leaves}} = \text{the sett or porter on each leaf.}$$

Thus, suppose a cloth is to be woven by means of 8 leaves in a 60 sett or 60 porter or portie, then

$$\frac{60 \text{ sett}}{8 \text{ leaves}} = 7\tfrac{1}{2} \text{ sett or porter per leaf.}$$

If, however, the drafts are irregular, as in Figs. 14 and 15,

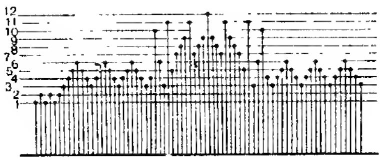


FIG. 14.

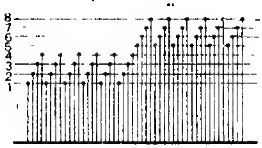


FIG. 15.

FIGS. 14, 15.—Two different drafts.

a slightly different method is necessary. Say, for example, that a 60-sett or 60-porter dice cloth is to be made according to the draft in Fig. 15. The same proportions still obtain with regard to the quantity on each leaf. Thus—

$$\frac{60 \text{ sett}}{8 \text{ leaves}} = 7\tfrac{1}{2} \text{ sett per leaf.}$$

But it must be remembered that for every mail knitted there is, proportionately, a place missed, and hence the rate of knitting is, in reality, equivalent to—

$$\frac{60 \text{ sett } (1 \text{ knit} + 1 \text{ missed})}{8 \text{ leaves}} = \frac{120}{8} = 15 \text{ sett in knitted portions;}$$

and this is general for all such healds, no matter how wide or how narrow the various rectangles are in the cloth.

Now, suppose that a 60-sett cloth were required to be woven with the threads drawn as illustrated in the draft in Fig. 14. This draft would naturally be repeated the necessary number of times to embrace all the threads in the warp for the width required; and, except in very special cases of exceedingly long drafts, the fact of its being necessary to have an incomplete draft near each selvage need not be considered with regard to the knitting of the healds.

TABLE I.

Leaves in the Group taken Singly.	Unit Sett per Thread.	Threads in Draft.			Sett per Leaf.
Leaf No. 1 requires	$\frac{60}{71} \times$	3	$\frac{180}{71}$	=	$2\frac{38}{71}$
" 2 "	" $\times$	3	$\frac{180}{71}$	=	$2\frac{38}{71}$
" 3 "	" $\times$	10	$\frac{600}{71}$	=	$8\frac{32}{71}$
" 4 "	" $\times$	14	$\frac{840}{71}$	=	$11\frac{59}{71}$
" 5 "	" $\times$	14	$\frac{840}{71}$	=	$11\frac{59}{71}$
" 6 "	" $\times$	8	$\frac{480}{71}$	=	$6\frac{54}{71}$
" 7 "	" $\times$	4	$\frac{240}{71}$	=	$3\frac{27}{71}$
" 8 "	" $\times$	4	$\frac{240}{71}$	=	$3\frac{27}{71}$
" 9 "	" $\times$	4	$\frac{240}{71}$	=	$3\frac{27}{71}$
" 10 "	" $\times$	2	$\frac{120}{71}$	=	$1\frac{49}{71}$
" 11 "	" $\times$	4	$\frac{240}{71}$	=	$3\frac{27}{71}$
" 12 "	" $\times$	1	$\frac{60}{71}$	=	$\frac{60}{71}$
					60 sett.

There are 71 threads in one repeat of the draft in Fig 14, and no matter what sett or porter the cloth is, each thread in this draft represents $\frac{1}{71}$ of the sett. Hence, in the particular case under notice, 60 sett, each thread or mail in the draft represents a set equivalent to $\frac{60}{71}$.

This example or sett has been chosen purposely to exhibit unfavourable numbers. In most cases in practice the examples would be much simpler, although the principle would be the same. Even in this case it is unnecessary to take each leaf separately. In general it is much simpler to take them in groups according to the number of threads per leaf in the draft. Thus—

TABLE II.

Leaf or Leaves.	Mails in each Repeat of Draft.	Unit Sett per Thread.	Mails per Draft.	Number of Leaves.	Sett on Leaves.
12	1 =	$\frac{60}{71}$ ×	1 ×	1 =	$\frac{60}{71}$ on 1
10	2 —	,, ×	2 ×	1 —	$1\frac{49}{71}$ on 1
1 and 2	3 —	,, ×	3 ×	2 =	$5\frac{5}{71}$ on 2
7, 8, 9, and 11	4 =	,, ×	4 ×	4 =	$13\frac{37}{71}$ on 4
6	8 =	,, ×	8 ×	1 —	$6\frac{54}{71}$ on 1
3	10 =	,, ×	10 ×	1 =	$8\frac{32}{71}$ on 1
4 and 5	14 =	,, ×	14 ×	2 —	$23\frac{47}{71}$ on 2
					60 sett on 12

The straight drafts on any number are simply particular cases of the above general case. Thus—

$$60 \text{ sett on 4 leaves} = \tfrac{1}{4} \text{ of 60 sett per leaf.}$$
$$= \frac{60}{4} \text{ sett per leaf.}$$
$$= 15 \text{ sett per leaf.}$$
$$\text{And 60 sett on 8 leaves} = \frac{60}{8} \text{ sett per leaf.}$$
$$= 7\tfrac{1}{2} \text{ sett per leaf as before.}$$

Another way of stating the above general proposition is—

$$\frac{\text{Sett of cloth} \times \text{mails per draft on any leaf}}{\text{Number of mails or threads in draft}} = \text{sett on that leaf.}$$

Example: In the draft in Fig. 14 the 6th leaf has 8 threads, therefore the sett on this leaf, if the cloth is 60 sett, is—

$$\frac{60 \times 8}{71} = \frac{480}{71} = 6\tfrac{54}{71} \text{ sett as in Table I.}$$

The method illustrated in the first table is, however, in most cases the quicker one.

Heald knitters have different methods of conducting the operations for spaced healds, and it is quite conceivable that in some cases the calculated sett required for the leaf with the most mails per draft may be impracticable, and that two leaves with half the calculated sett on each might be necessary to take the place of one. If, however, it were possible to knit the finest sett calculated on any leaf, and it were decided to knit the required healds on all the other leaves to the same sett—which may or may not be done — it would be easy to supply the knitting particulars.

In the draft in Fig. 14 leaves 4 and 5 are the finest so far as the number in a given width is concerned, while leaves 3 and 6 are the next in order of fineness. Suppose that it were decided to knit these on the basis of 60 sett on four leaves, and it would be desirable to do so, and even necessary if the pointed draft on these four leaves were continued for an inch or two instead of for a few threads—a condition in practice which is quite conceivable—then the rate of knitting would be equivalent to 15 sett on each leaf, although the actual quantity of mails in the combined repeats of the draft would be represented by the values found in the following table.

No. of Leaf.	Rate of Knitting.	Actual Sett on Leaf.	Blanks Equal to Sett.
3	15	$8\frac{3}{7}\frac{2}{1}$	$6\frac{2}{1}\frac{0}{1}$
4	15	$11\frac{5}{7}\frac{9}{1}$	$3\frac{1}{7}\frac{2}{1}$
5	15	$11\frac{2}{7}\frac{1}{1}$	$3\frac{1}{7}\frac{2}{1}$
6	15	$6\frac{5}{7}\frac{4}{1}$	$8\frac{1}{7}\frac{7}{1}$

In some groups of spaced healds different rates of knitting obtain according to the character of the draft, and each one must be considered independently of any general rule.

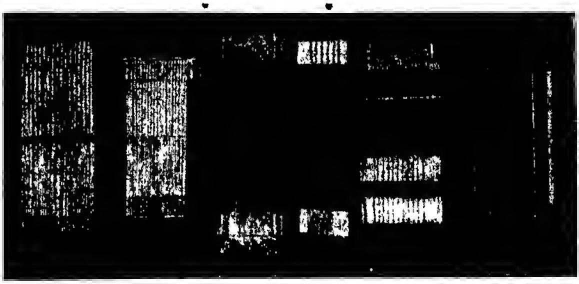
It is unusual to have healds spaced or knitted to the draft unless there is a probability of the group of healds being kept in use for a reasonable period; the equivalent spacing of the healds for the group which is to be used for the original pattern in pattern weaving is generally, but not invariably, obtained by the process of casting out or fileying.

For dice-pattern drafts, such as that illustrated in Fig. 15, it is not uncommon to have the healds arranged so that each or any heald may be moved along a "leading cord" according to the position in which it is required to appear. The number of healds required for each leaf will, of course, be found from the draft, and the number of repeats of the draft in the width; then the order is given for 8 or 10 leaves, each with the necessary number of hundreds of separate complete healds or heddles. Each individual heald is tied round the leading cord, and a group of such loose or sliding healds is shown at C, Fig. 16. The particulars for the various kinds illustrated in Fig. 16 are as under:—

A. Ordinary healds (unvarnished) with mails similar to those in Figs. 1 to 5.

B. All cotton knitted healds (unvarnished) in which the upper and lower heald twines are ingeniously

knitted to the two leading cords, and in which the eyes of the healds are also ingeniously formed simultaneously with the knitting of the whole. The eye in this case is similar to that illustrated in Fig. 17.



A B C D E F

FIG. 16.—Various kinds of healds and wires.

C. A group of individual healds prepared and varnished for dice and similar patterns, as mentioned above with regard to Fig. 15, and in which each and every heald can be slid to any desired position.

D. A specially prepared and varnished heald for heavy work and provided with mails. Each pair of heald cords from the mail is twisted as shown. They are not so convenient as the ordinary healds, but they last much longer.

E. A doup heald and doup half, or the standard heald and the doup heald. The doup half is raised in the figure, and a thin round rod is supporting the half healds. This particular one is made of cotton, but large quantities of such healds are made of worsted.

F. Various types of metal healds.

It is a very common practice in some districts to order the ordinary type of healds in a higher sett or porter than that of the cloth which is to be in almost general use. In such cases it is obvious that, whereas such a sett cannot be used for weaving a cloth of a finer sett,

FIG. 17.—Cotton eye on knitted heald.

it can be employed to weave any cloth in a lower sett by casting out or fileying those mails which are not required. In some cases, and particularly in the finer branches of the trade, it is usual to draw a thread through two successive eyes on the same leaf instead of allowing one of these eyes to remain unoccupied. This is done at all places, and on each leaf where the equivalent process of casting out should be performed.

The formula for the casting out, fileying, or double drawing, may be stated in two ways, and the one which happens to be the most convenient should be used. These two ways are as follows :—

$$\frac{\text{Sett of leaves in use} - \text{sett of cloth required}}{\text{Sett of leaves in use}}$$
$$= \text{the actual amount to be cast out};$$

or—

$$\frac{\text{Sett of leaves in use}}{\text{Sett of leaves in use} - \text{sett of cloth required}}$$
$$= \text{the interval of casting out, fileying, or drawing double.}$$

Example: Suppose a 48-sett cloth is to be woven by a 60-sett healds on any number of leaves. Then—

$$\frac{60 \text{ sett} - 48 \text{ sett}}{60 \text{ sett}} = \frac{12}{60} = \frac{1}{5} \text{ to be cast out;}$$

or—

$$\frac{60 \text{ sett}}{60 \text{ sett} - 48 \text{ sett}} = \frac{60}{12} = 5, \text{ the interval of casting out.}$$

In both cases it is clear that four gaits should be drawn and one gait missed. A "gait" indicates one heald or eye, and one only, on each leaf from front to back, however many leaves may be employed. It must be distinguished from the word draft, which indicates the number of eyes, in straight order or in irregular order, which are necessary for one unit or repeat of the pattern. It is obvious, however, that for the simplest drafts—*i.e.* straight ones—the number of eyes in both gait and draft is the same; nevertheless the distinction is desirable in all cases. In many cases, where various setts are used in the same group, it is impracticable to cast out full gaits; a common practice in such cases is to arrange the casting out on the front leaf only, unless two or more are alike, and to drop out those on the other leaves when it appears necessary. The more carefully this is done the more smoothly will the weaving proceed. Threads which do not come straight to the reed without rubbing against neighbouring heald cords give much trouble.

Again, suppose that a 13-porter cloth is to be woven with 18 porter healds (cambs); then—

$$\frac{18 - 13}{18} = \frac{5}{18} \text{ porter to be cast out or fileyed.}$$

In fractional cases such as this it is often simpler to use the other formula. Thus—

$$\frac{18}{18 - 13} = \frac{18}{5} = 3\tfrac{3}{5}, \text{ the interval of fileying or casting out.}$$

This interval is equivalent to the following: Miss the 4th gait for three times, and then miss the 3rd gait for twice. That is—

	Gaits Drawn.		Gaits Missed.
3 gaits drawn and 1 gait missed for 3 times =	9	...	3
2 ,, ,, 1 ,, ,, twice =	4	...	2
	13		5

The order as above is arrived at as under:—

(*a*) Draw as many gaits as the whole number in the interval of casting out (3 in this case) and miss one gait. This must be repeated for that number of times represented by the numerator of the fractional part of the fileying interval (again 3 in this case, since the fractional part is $\frac{3}{5}$).

(*b*) Draw as many gaits as the whole number minus one (in this case $3-1=2$), and miss one gait. This must be repeated for that number of times represented by the differences between the denominator and the numerator of the fractional part (in this case the denominator is 5 and the numerator is 3; hence $5-3=$twice).

There are thus two different orders of casting out, (*a*) and (*b*). Of these two orders it is desirable that each order should appear a minimum number of times in succession. Hence, instead of casting out exactly as shown by the numerical example above, it would be better to adopt the following equivalent order:—

3 gaits drawn,	1 gait missed.		
2 ,,	1 ,,		
3 ,,	1 ,,		
2 ,,	1 ,,		
3 ,,	1 ,,		
13	5	= 18.	

If the student finds any difficulty in carrying out the process as stated, he might adopt the method illustrated in Fig. 18. Marks of any kind and equal to the sett of the healds are placed on paper. At A, Fig. 18, there

are 18 circles to represent the sett; then 5 are crossed out to indicate the proportion to be cast out, and, naturally, 13 remain, represented by the solid circles. The lower set B shows the same number cast out, but by the method

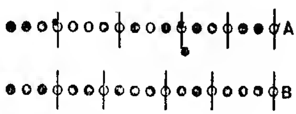


FIG. 18.—Diagrammatic view of casting-out.

which distributes the casting out in the most satisfactory way. It is usual to insert a cord, as shown at W, Fig. 1, to indicate those gaits which are to be cast out. In this figure the cord W passes in front of nine healds and behind the tenth, indicating that nine gaits are to be drawn and one gait missed.

All similar cases can be treated in the same manner for straight drafts, or for drafts in which each leaf has the same number of mails in use, and in which no wide

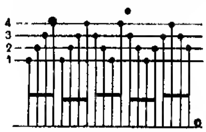


FIG. 19.—Pointed draft.

interval obtains between successive drafts on the same leaf. It must be remembered however, that the casting-out should be in gaits and not in mail-eyes, otherwise the pattern in the cloth would be broken.

Even for some of the simple drafts, however, it is necessary to be careful, and to modify the arrangement slightly. For example: Suppose a 1400's cloth (usually

written 14^{00}) is required to be woven to the draft shown in Fig. 19. The minimum sett for these four healds should be that which would accommodate six mails on each leaf per repeat, instead of six mails on leaves 2 and 3, and four mails on leaves 1 and 4. This suggested arrangement would be equal to—

$4 \times 6 = 24$ mails per repeat for the accommodation of 20 threads,

instead of—

$2 \times 6 + 2 \times 4 = 20$ mails per repeat for 20 threads.

Hence, instead of a 14^{00} sett on four leaves, we should require the following:—

$$1400 \times \frac{24}{20} = 1680, \text{ or } 16^{80} \text{ sett, or } 16^{80} \div 4$$

$$= 4^{20} \text{ sett on each leaf.}$$

Leaves 1 and 4 have four threads per repeat of the draft and six mails per repeat for service; hence—

$$\frac{6-4}{6} = \frac{2}{6} = \frac{1}{3} \text{ to be cast out on leaves 1 and 4,}$$

but all the mails on leaves 2 and 3 would be occupied.

Summarised, the arrangement is as under:—

Leaf 1.	420	- 140 cast out	=	280	occupied.
,, 2.	420		=	420	,,
,, 3.	420		=	420	,,
,, 4.	420	- 140 cast out	=	280	,,
	1680	- 280 ,,	=	1400	

The horizontal lines under the draft show one method of indicating the reeding; in this case each line crosses four threads, hence there would be four threads per split.

The student should calculate a set of spaced healds for this example.

CHAPTER IV

WIRE HEALDS

WIRE HEALDS.—The ease with which the modern wire healds can be moved along their shafts or rods, and so accommodate themselves to any desired change, makes this class of heald exceptionally useful for drafts in which there is any irregularity. And, within wide limits, wire healds are equally suitable for many, if not all, classes of ordinary work in which the draft is perfectly straight. The eyes A can be made of any desired size or shape, as is demonstrated by the illustration of a few types in Fig. 20, while Fig. 21 shows a leno heald G, a jacquard

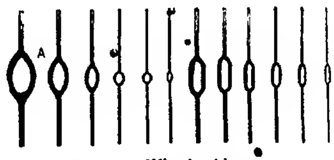


FIG. 20—Wire heald eyes.

harness H with solid-steel mail eye, and a complete heald F of one type. It will be understood that several of these healds—the maximum number required for any particular leaf—are threaded on two flat steel rods, with rounded edges, to facilitate their movement, and to reduce friction and wear and tear. These rods, somewhat rectangular in section in this case, but perfectly circular

in other cases, pass through the holes in the two ends of the heald frame. After providing the necessary number of healds on the top and bottom steel rods, the latter are attached in various ways to the upper and lower

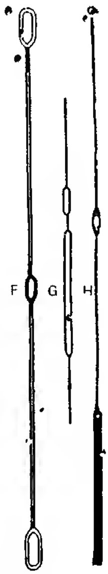


FIG. 21.—Wire heald eyes.

wooden staves as illustrated in Fig. 22, and the whole securely bound by two end pieces, one of which is shown at B. The whole leaf is built up in such a way that part of the healds may be removed if desired or necessary, or additional ones may be threaded on without much trouble.

Another modification is a "combination knitted and wire heald." In this case the upper and lower parts which encircle the upper and lower wooden staves are knitted somewhat similarly to the ordinary cotton or worsted healds; each loop is attached automatically to the upper or lower hole of the wire heald. This form of heald is

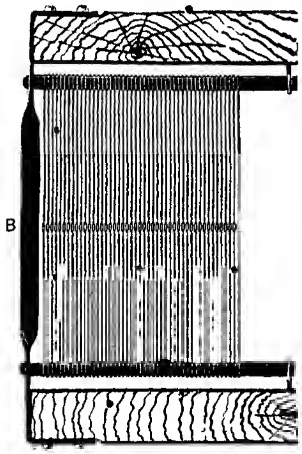


FIG. 22.—Wire heald frames.

obviously not intended for the healds to slide, but is simply what is considered to be a suitable form of heald embodying good points from two systems, and intended for fine setts where a change of sett is not required.

At C in Fig. 23 is shown the method of adding healds to a sett already drawn in. These repairing healds are left unsoldered at the end twists, so that they can be untwisted as at C, put over the rods and twisted up again as at D. It provides a very convenient way of

repairing a worn or damaged heald, or if an end has been missed in the drawing-in, a repairing heald can be put on at the place. The rod E shows a form of stay rod used to increase the stability of the healds, and to prevent the pull of the heald cords from distorting the

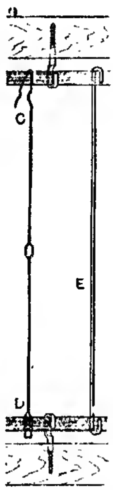


FIG. 23.—Wire heald frames.

heald frame. One, two, or more stay rods may be used on each heald stave according to the width.

For heavier work, each frame of healds may be provided with double rods at the top and bottom. This arrangement has a double significance—it provides a strong, substantial heald for heavy fabrics, and one which in many cases necessarily contains a large eye, while the two rods distribute the healds in two rows, as explained in connection

with Figs. 2 and 4, so that the requisite number of healds can be accommodated on the leaf.

It is quite obvious that with proper arrangements with regard to the standard wire heald Fig. 22, no empty mails or healds need appear among those which are actually required for the warp threads, no matter how simple or how complicated the draft may be. The surplus healds may be left at the two ends provided that there is room for them. In general there will be ample room, but if otherwise it would evidently be necessary to take some of the healds off. The actual process of casting out or fileying at certain intervals is in consequence dispensed with entirely; moreover, one is always sure that the space occupied by the threads in the reed will coincide with that occupied by the threads in the healds, for the simple reason that the latter are immediately placed in line with the former in virtue of the freedom with which they can be made to slide on their rods. When we say that the width of the threads in the healds and in the reed will coincide, we are neglecting the difference between the width of the threads on the back rail of the loom and that of the same threads in the reed; to be correct, we should say that each heald will move on its rods to the most natural and satisfactory position, such position being in the straight line between the point which the thread occupies on the warp beam or on the back rest of the loom and the split of the reed through which it passes. The actual position in the split of the reed is clearly determined at and near the selvages by the shrinkage in width between the reed and the cloth.

The importance of the relative widths occupied by the threads in the healds and in the reed cannot, or should not, be neglected. One need hardly say that a faulty calculation with regard to the casting out in ordinary healds may lead to extra work and to disastrous results.

The writer has recollections of a very fine warp, on a large number of healds and with a complicated draft, having to be drawn in—not wholly, but partially—three times, simply because of the incorrect casting-out calculation; while on another occasion a fine warp, containing upwards of 5000 threads, was found, when loomed and ready for weaving, to be about one inch narrower in the healds than in the reed. The warp was obviously unworkable under the circumstances, and the drawer-in, in order to save himself the trouble of re-drawing and re-reeding the warp, foolishly cut the leading cords of each leaf at several places, both at the top and bottom, in order that the several severed sections could slide and thus reach the width occupied by the threads in the reed. Needless to say, the healds, which happened to be new ones, were completely spoiled by this foolish attempt to cover a mistake brought about by more or less guesswork in connection with the casting out. Guesswork in casting out is also responsible for much friction on the threads between the healds and the reed, and hence for an increased number of broken threads. On the other hand, it is quite possible to make the calculations for, and to draw in the threads of, hundreds of warps without making a serious mistake in the casting out, or introducing faults by casting out the correct number of gaits at the wrong positions.

It is not claimed that perfection has been secured in wire healds, nor can one expect to achieve this ideal condition in any kind of heald. Each departure from the ordinary methods usually introduces advantages and disadvantages, and it is for the users to determine which are predominant. For example, it is quite obvious that with the present construction of wire healds it is impossible to use the laths M, Fig. 5, in exactly the same way as is illustrated in that figure. Nevertheless, the laths M may be introduced between each pair of leaves, and raised by

similar means until their upper surfaces show clearly the lines of eyes for the drawer-in. In this respect, however, the advantage will probably always be on the side of the ordinary heald. But, so far as this phase is concerned, it is only a question as to how much longer it would take to draw in the warp through wire healds than it would to draw a similar warp through the ordinary healds when the laths M are inserted between the heald twines, as in Fig. 5. This should not be a difficult thing to decide. We are perhaps correct in stating that one should not always fix the choice of a certain article by the actual time which it takes to fill that article—whether this be drawing-in, beaming, dressing, or other method; but should consider carefully what effect that article or its contents has or have upon subsequent processes, especially when subsequent processes are lengthy, as in the case of weaving.

The ease with which a weaver can insert her hands between the ordinary cotton healds to take up broken threads is well known, and, although wire healds slide freely on their rods, it cannot be expected that the same flexibility will obtain with metal healds as with fibrous healds. Then, again, there is the relative life of the two kinds when operating various thicknesses and kinds of fibrous warps, and differently starched warps, taking into consideration the initial cost of each kind of heald; the damage done to the threads when a heald of either kind breaks; the facility with which each can be repaired; the cost of upkeep as regards both material and time; the conditions under which each works in the loom; the degree of adaptation for various kinds of drafts and setts; and the production from the looms over a lengthened period which should be long enough to embrace the life of that particular kind which stood the test for the longest period. In some types of delicate and valuable warp yarns it might

be necessary to consider the relative amount of friction and its effect upon the threads and the cloth in the two cases; and there are probably other special phases which might lead one to consider carefully which particular type of heald he should use, and of what material that heald should be made. We are not recommending any type, but simply stating conditions which might be essential or desirable to be considered by those in charge.

CHAPTER

DESCRIPTION OF REEDS AND METHOD OF MANUFACTURE

REEDS.—With few exceptions, and almost negligible exceptions, healds and reeds are inseparable in the process of weaving simple fabrics. But whereas the healds may be said to perform one operation only—that of separating the warp threads into the necessary number or groups between which is passed a shuttle, two shuttles, a wire, or other implement, or a combination of these articles,—the reed may be considered as fulfilling a quintuple function.

1. It places the successive picks of weft in close proximity to each other, technically termed "beating up."
2. It forms the back support for the shuttle as the latter travels from side to side with the weft.
3. It keeps the respective small groups or splitfuls of warp approximately equidistant.
4. Under certain conditions and construction it enables special effects to be produced by imparting to it a vertical movement; and even without vertical movements it is capable of adding variety in virtue of irregular reeding or denting.
5. Neglecting the degree of shrinkage, it fixes the pitch of the threads; in other words, it determines the fineness or coarseness of the fabric.

This functional division might reasonably be challenged, particularly with regard to the fixing of the pitch of the threads, or what is more generally known as the "sett" or the "porter" of the cloth. As a matter of fact, it is the

healds which fix the sett and not the reed, for it is well known that for some cloths reeds of different fineness may be used without altering the actual sett, and without affecting sensibly the general appearance of the fabric. A change to a coarser kind of reed is often resorted to in order to enable the weaving to be done with more ease and with fewer warp breakages; while a finer reed may, in other cases, be used to impart a more regular distribution of the

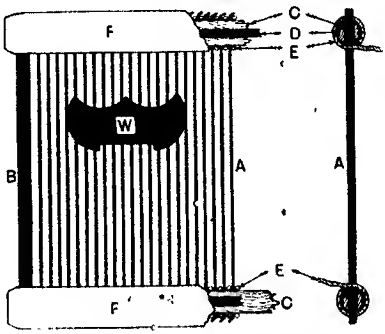


FIG. 24.—Reeds and counting gauges.

warp threads so as to obtain good cover—*i.e.* to prevent reed-marking or reediness. In such cases the change is considered simply as one of convenience. No corresponding change, however, can be made with the ordinary healds, and hence, in this respect, one might with confidence attribute the fixing of the sett to the arrangement in the healds, although the reed is necessary to make such a distribution practicable in weaving.

On the other hand, when the reed and the average number of threads per split are considered jointly, the sett is defined as accurately as, and, indeed, more accurately than, is possible with the healds alone, for the parts of the

former are more or less rigid, while those of the latter are very flexible. In all cases, therefore, the actual number of threads in any given width can be determined by the number of splits in that width multiplied by the average number of threads per split. This is probably the reason why the "sett" or "porter" of a cloth is often made with reference to the reed.

Fig. 25.

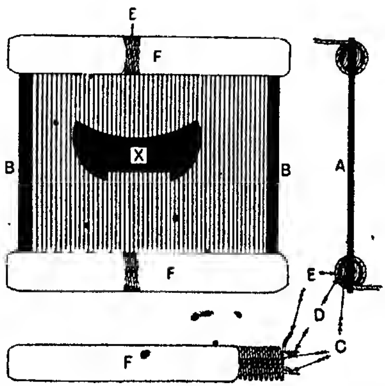


Fig. 26.

Figs. 25, 26 —Reeds and counting gauges.

The splits of a reed are invariably considered as the openings between the reed wires. Thus Figs. 24 to 26 are views of two types of the same kind of reed, and these are introduced mainly to show the difference in dimensions and the general structure. The wires of the reed in Fig. 25 are nearer to each other than the corresponding wires in Fig. 24; indeed, the former reed, when compared with the latter reed, contains double the number of wires, and therefore double the number of splits in a given width.

A brief description of the structure of the ordinary type of reed and the method of manufacture may prove interesting to many who are well acquainted with reeds, but who have had no opportunity of seeing them made. Most reeds consist of the following parts:—

A — the ordinary reed wires.
B — the strengthening end wires.
C — the thin laths or boards.
D — the thin strengthening wires.
E — the tarred binding cord.
F — the paper cover.

The various views in Figs. 24 to 26 indicate the structure sufficiently well.

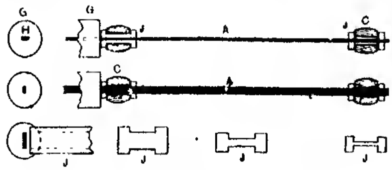


FIG. 27.—Details of reed manufacture.

The flat reed wires A are originally in one continuous length, and this length of wire is wound on a reel or grooved pulley. At the reed making machine the wire A passes between two rollers which are positively driven by wheel gearing. After the wire leaves the rollers it passes through a rectangular slot in the guide G, Fig. 27, with the slot horizontal, as shown by the black rectangle H near the centre of the guide G. The wire A passes through as shown in the upper diagram. The two pairs of laths C are kept the proper distance apart by the metal gauge J; three views of different gauges appear detached in the figure—these are for wide, medium, and narrow reed wires. The reed is horizontal and on its side during the process of

manufacture, and somewhat as illustrated in the two upper views in Fig. 27, and the wire A has naturally to pass between the two pairs of laths C as shown. The delivery of the wire A is intermittent; thus, after the wire has been drawn forward sufficiently far to pass through as shown in the upper figure, the drawing action of the rollers is arrested. A cam on the side of the upper roller comes against the lower roller, forces the latter downwards slightly, and thus creates a gap between the drawing surfaces; hence, the wire A at this moment is unaffected by the rollers, and remains so until the cam passes round and enables a spring to raise the bottom roller close to the top one. The raising of the bottom roller thus causes both rollers to grip the wire again, and to carry another length forward.

Immediately the wire A is arrested—*i. e.* when it is in the position indicated in the upper view in Fig. 27—a quadrant causes the guide G to make a quarter of a revolution. This quarter turn of the guide places the reed wire on its edge as illustrated in the middle figure, and the appearance of the rectangular slot will then be vertical. The width of the central section of the metal gauge J is therefore arranged for the depth of reed wire.

Simultaneously with the introduction of the wire, two reels of tarred twine, kept hot by gas jets, are rotated round the laths C—one reel round each pair of laths,—and these place rounds of twine somewhat as illustrated in Figs. 24 to 26. One round is sufficient for very fine reeds, but as the reeds get coarser, more rounds and thicker cord is wound round in a similar manner. Several plies up to 30 are used in the thicker cords.

A cam now causes two sliding sleeves, in which the gauges J are held, to move towards the newly introduced wire A—which is on its edge—and to push up the round or rounds of twine. At the same time one of the sleeves

passes close in front of the rectangular guide, and severs the reed wire at this point. The gauge J in the lower left-hand position is shown just before it reaches the wire in the vertical rectangular slot.

This operation is repeated for each wire A, and meantime the partially made reed is carried forward a distance equal to the pitch between the reed wires A in the particular sett under construction by means of a train of wheels and a screw-feed similar to those in a lathe.

A heavy strengthening and identification wire B is the first one inserted at the commencement of a new reed, after the laths C and the wires D have been placed at their proper distances apart and secured in this position. A similar heavy wire B is inserted when the reed has reached its desired length—usually termed the width.

The "sett" or "porter" of the reed is invariably stamped on these heavy and broad wires B. In practice it is not uncommon for these end wires to be knocked off by constant use, or perhaps cut off in order to utilise the reed for a narrower loom than that for which it was built, or to enable the reed to be placed in its proper position with regard to the threads in the healds when the operation of reeding has not been commenced at the proper distance from the end of the reed. If desired, a further identification mark may be introduced. The gauge W in Fig. 24, or X in Fig. 25, may be used to count the reed. (This will be explained later.) Thus, between the extremities of the upper part of the gauge in Fig. 25 are 27 splits or openings; hence, this gauge might indicate a 27 sett or a 27 porter reed. It is evident that if brass reed wires or black steel reed wires were inserted into the reed so that adjacent pairs were the same distance apart as the points of the gauge, it would be an easy matter to count the reed without a gauge.

A somewhat simpler method is often adopted by introducing a number of brass or black reed wires near the

middle of the reed. Thus, suppose the reed is 50 sett or 50 porter, ten ordinary reed wires would be bounded by two brass ones in the following manner: 1 brass wire, 10 steel wires, 1 brass wire. Each of the ten steel wires in this case would represent 5 sett or 5 porter; hence, 10 wires × 5 sett each = 50 sett reed.

If the sett happened to be a number which was not a multiple of 5, say, 49 sett, then the arrangement would be:—

$$1 \text{ brass}: \underbrace{9 \text{ steel}}_{9 \times 5} \quad \underset{+}{1 \text{ brass}} \quad \underbrace{4 \text{ steel}}_{4 \times 1} \quad 1 \text{ brass} = 49 \text{ sett.}$$

That is, each steel wire in the large group represents 5 sett to the largest multiple of 5 under the actual sett, and each steel wire in the second group represents 1 sett.

A further example for a 52 sett reed would be:—

$$1 \text{ brass}: \underbrace{10 \text{ steel}}_{10 \times 5} \quad \underset{+}{1 \text{ brass}} \quad \underbrace{2 \text{ steel}}_{2 \times 1} \quad 1 \text{ brass} = 52 \text{ sett.}$$

For finer setts each wire might represent 10 sett, while for coarser setts each wire might represent any convenient number under 5 sett.

After the reed is built, it is removed from the frame, and the ends are "clinked" or forced down as shown in Fig. 24 by means of an old file or rasp. When thus bent, the reed wires are more rigid than if they are unbent as shown in the end views. The latter are, however, more easily withdrawn when it becomes necessary to replace worn or broken reed wires, as is often necessary in comparatively fine reeds. The reed is now examined, the ends trimmed, and wires straightened if any irregularity prevails, and, finally, the tarred boards are covered with stout blue paper.

CHAPTER VI

SETTS AND PORTERS OF HEALDS AND REEDS

The gradual development of any industry is invariably accompanied by diverse methods of performing analogous functions—mechanical or arithmetical. This diversity is often due to local requirements, and is perhaps as fully pronounced in the "sett" systems as in most branches. The choice of any particular system would probably be made with respect to the original width of the most widely manufactured cloth in any particular district, and as the varieties and widths multiplied, it is only natural to expect that in most instances the original chosen unit width or base would be adhered to, and all other widths of cloth obtaining in the same district calculated from this unit base. There are few, if any, persons who work by the British unit of measurement—the inch, or multiples of an inch, or fraction of an inch—who are not convinced that the simplest arrangement would be the number of splits per inch, or the number of splits in two inches. And all would undoubtedly be prepared to adopt one or other of these systems if the only obstacle to the change were an arithmetical one. Established customs, however, are difficult to break down, and any radical change—such as altering the denomination of fabrics—which affects the usual course in a mill or factory often leads, for a time, to decreased production, to increased clerical work, to expense, and to lengthy and technical explanations between

producer and customer, for the change naturally affects antecedent and subsequent industries. If one system, whatever that system should be, is proved to the satisfaction of those engaged in the industry to be the best, then by all means let no effort be spared to introduce it generally; but it would be advisable to get all shades of opinion, and to keep in mind that one of the greatest obstacles to changes, although not the only one, is the human element.

Until such unification is possible, each district will probably continue to use its own established custom, and will compare with other systems in the usual way when necessary or desirable.

It matters little whether the sett or porter is reckoned by the number of splits or by the number of threads, although, all things considered, the former method is, perhaps, the better one. Thus one may consider that a "beer" or a "porter" or a "portic" contains 40 threads or the arbitrary equivalent, 20 splits (in this case it is considered that two threads appear in each split). Similarly, if 38 threads are considered a "beer" or "portic," the equivalent number of splits would be 19. But since it is advisable to keep the beer, portic, or porter constant in any one district, and equivalent to 40 or 38 threads, and since this group of threads could obviously be arranged in many different ways so as to employ different numbers of splits in the reed, and hence different widths in the same reed, it is perhaps the better way to state the value of the beer, portic, or porter in terms of the reed, and on the basis of two threads per split—*e.g.* 20 splits or 19 splits—and then to make the necessary alterations in the number per split according to the type of fabric, or to the effect desired.

Table III. (page 62) indicates the methods adopted in various districts.

TABLE III.

1.	Huddersfield .	Number of splits in 1 in.
2.	Stockport . .	" " 2 in.
3.	Bolton . . .	Number of beers of 40 thread each in 24¼ in.
4.	Preston[1] . .	" " " 34 in.
5.	Bradford . .	" " " 36 in.
6.	Blackburn . .	" " " 45 in.
7.	Leeds . . .	Number of beers or porties of 38 threads each in 9 in.
8.	Holmfirth . .	10 threads per foot, or 5 splits in 12 in.
9.	Dewsbury . .	Number of porties of 38 threads each in 90 in.
10.	Macclesfield .	Number of hundreds of splits, n^{00} in 36 in.
11.	Glasgow and West of Scotland	" " " 37 in.
12.	Irish . . .	" " " 40 in.
13.	Dundee and East of Scotland	Number of porters of 40 threads each in 37 in.
14.	Continental or Metrical	Number of splits in 1 centimetre.
15.	" "	" " 1 decimetre.

Although the unit or fundamental reed may be impracticable so far as actual weaving is concerned, it serves as an excellent base from which all others in the same system may be quickly calculated. The number of splits per inch in the fundamental reed in any system is—

$$\frac{\text{Unit number of splits}}{\text{Reed base}} = \text{splits per inch.}$$

In Table IV. (page 63) we give the splits per inch, or what may be used as a constant number, for each of the above fifteen different systems.

The number of splits per inch for any particular "sett" or "porter" can then be found by multiplying the value in the last column of Table IV. by the particular sett or porter required. Thus—

Splits per unit sett × sett required = the splits per inch in that sett.

[1] The Stockport system is now used almost exclusively in this and several other Lancashire towns. The Huddersfield system is largely used in America.

TABLE IV.—SPLITS PER INCH.

1.	Huddersfield	$1 \div 1$	$= 1$		
2.	Stockport	$1 \div 2$	$= \frac{1}{2}$	or	$0\cdot5$.
3.	Bolton	$20 \div 24\frac{1}{4}$	$= \frac{80}{97}$	,,	$0\cdot82474$.
4.	Preston [1]	$20 \div 34$	$= \frac{10}{17}$	,,	$0\cdot58824$.
5.	Bradford	$20 \div 36$	$= \frac{5}{9}$	,,	$0\cdot\dot{5}$.
6.	Blackburn	$20 \div 45$	$= \frac{4}{9}$	,,	$0\cdot\dot{4}$.
7.	Leeds	$19 \div 9$	$= \frac{19}{9}$	,,	$2\cdot\dot{1}$.
8.	Holmfirth	$5 \div 12$	$= \frac{5}{12}$	,,	$0\cdot41\dot{6}$.
9.	Dewsbury	$19 \div 90$	$= \frac{19}{90}$	,,	$0\cdot2\dot{1}$.
10.	Macclesfield	$100 \div 36$	$= \frac{25}{9}$	,,	$2\cdot\dot{7}$.
11.	Glasgow and West of Scotland	$100 \div 37$	$= \frac{100}{37}$	,,	$2\cdot\dot{7}0\dot{2}$.
12.	Irish	$100 \div 40$	$= \frac{5}{2}$	,,	$2\cdot5$.
13.	Dundee and East of Scotland	$20 \div 37$	$= \frac{20}{37}$	,,	$0\cdot5\dot{4}0\dot{5}$.
14.	Continental or Metrical	$1 \div 0\cdot3937$	$= \frac{160}{63}$	,,	$2\cdot53969$.
15.	,, ,,	$1 \div 3\cdot937$	$= \frac{16}{63}$	,,	$0\cdot25397$.

The same result could obviously be got as follows—

$$\frac{\text{Sett} \times \text{splits in unit sett}}{\text{Reed base}} = \text{splits per inch.}$$

Example: Find the number of splits per inch in 80 sett Bradford system. The Bradford unit is $0\cdot\dot{5}$; hence—

[1] The Stockport system is now used almost exclusively in this and several other Lancashire towns. The Huddersfield system is largely used in America.

$$0.555 \times 80 \text{ sett} = 44.4 \text{ splits per inch; or,}$$

$$\frac{80 \text{ sett} \times 20}{36} = 44\tfrac{4}{9} \text{ splits per inch.}$$

The total number of splits in use is then found, naturally, by multiplying this value by the width which the warp threads occupy in the reed.

It is sometimes necessary to convert the sett in one system to the equivalent sett in some other system. Let G represent the given system, and R the required system. Then, since these two setts must contain the same number of splits per inch, whatever happens to be the number by which the sett of each is recognised, it follows that—

$$G \times \text{splits per inch of } G = R \times \text{splits per inch of } R;$$

hence—

$$\frac{G}{R} = \frac{\text{splits per inch of } R}{\text{splits per inch of } G};$$

or conversely—

$$\frac{R}{G} = \frac{\text{splits per inch of } G}{\text{splits per inch of } R};$$

hence—

$$R = \frac{G \times \text{splits per inch of } G}{\text{splits per inch of } R}.$$

Example: Suppose the given sett G is 80 sett in the Bradford system, and the required sett should be the Blackburn system; then, consulting Table IV., we have—

$$\text{Blackburn sett} = \frac{\text{Bradford sett} \times \frac{5}{9}}{\frac{4}{9}}$$

—*i. e.*

$$\text{Blackburn sett} = \frac{80 \times \frac{5}{9}}{\frac{4}{9}}$$

$$= \frac{80 \times 5 \times 9}{9 \times 4}$$

$$= 100 \text{ sett Blackburn.}$$

Again, the same result may be obtained by introducing all particulars of the two systems. Thus—

$$\text{Blackburn sett} \times \frac{20}{45} = \text{Bradford sett} \times \frac{20}{36}.$$

Hence, for 80 sett Bradford we have—

$$\text{Blackburn sett} = \frac{80 \times 20 \times 45}{36 \times 20}$$

$$= 100 \text{ sett.}$$

An obviously shorter method is to ignore the terms 20, which cancel; but, nevertheless, such a method does not, perhaps, explain the principle with sufficient clearness. The conversion for any other pair of systems can be performed similarly.

It will be seen from the last of the above examples that the conversion of a given sett in system G to the equivalent sett in system R is obtained by multiplying the given sett G by its constant number—*i. e.* $\frac{\text{unit splits}}{\text{reed base}}$, and dividing by the constant number of the required system R.

In Table V. (page 67) we have arranged the values so that the conversion numbers may be seen at a glance. Thus, the first column, before the names of the districts, indicates the formulæ for obtaining the splits per inch or constant numbers in the fifteen different systems considered. The values in the first column after the names of the districts—that is, those under the name "Huddersfield"—are the

same, but they are arranged, where possible, in a more suitable form. The list of names in the fifteen districts appears horizontally, above the list of figures, as well as vertically, and all the horizontal values after each name in the vertical list are obtained by dividing the constant number of any particular name of district by the constant number of all the others in succession. In general—

$$\frac{\text{Formula for splits per inch in systems of vertical names}}{\text{Formula for splits per inch in systems of horizontal names}},$$

and the result of this division is clearly the value which must be multiplied by the given sett G to obtain the required sett R.

For example, the above-mentioned 80 sett in the Bradford system is equivalent to 100 sett in the Blackburn system, as already found in two ways. Opposite the name Bradford in the vertical list of names is the value $\frac{5}{9}$; on the same horizontal row of values, and under the column headed Blackburn, is $\frac{5}{4}$. This $\frac{5}{4}$ is the conversion number from Bradford sett to Blackburn sett, and has been found as explained above, thus—

$$\text{Bradford constant} \div \text{Blackburn constant}$$

$$\frac{20}{36} \div \frac{20}{45}, \text{ or } \frac{5}{9} \div \frac{4}{9}$$

$$= \frac{5}{9} \times \frac{9}{4} = \frac{5}{4}.$$

Hence, 80 sett Bradford is—

$$80 \times \frac{5}{4} = 100 \text{ sett Blackburn;}$$

and so on for any others.

In Table V. (page 67) the first horizontal row of fractions represents the sett or porter in fourteen systems as

Unit No. of Splits + Reed Base.	District or Town.	Huddersfield.	Stockport.	Bolton.	Preston.	Bradford.	Blackburn.	Leeds.	Holmfirth.	Dewsbury.	Macclesfield.	Scotch.	Irish.	Dundee.	Splits per Centimetre.	Splits per Decimetre.
1	Huddersfield	1	2	97/80	17/10	9/5	9/4	9/19	12/5	90/19	9/25	37/100	2/5	37/20	63/160	63/16
1/2	Stockport	1/2	1	97/160	17/20	9/10	9/8	9/38	6/5	45/19	9/50	37/200	1/5	37/40	63/320	63/32
20/24¼	Bolton	80/97	160/97	1	136/97	144/97	160/97	720/1843	102/97	7200/1843	144/485	148/485	32/97	148/97	63/194	315/97
20/34	Preston	10/17	20/17	97/136	1	18/17	45/34	90/323	24/17	900/323	18/85	37/170	4/17	37/34	63/272	315/136
20/36	Bradford	5/9	10/9	97/144	17/18	1	5/4	5/19	4/3	50/19	1/5	37/180	2/9	37/36	7/32	35/16
[illegible]/45	Blackburn	4/9	8/9	97/180	34/45	4/5	1	4/19	16/15	40/19	4/25	37/225	8/45	37/45	7/40	7/4
19/9	Leeds	19/9	38/9	1843/720	323/90	19/5	19/4	1	76/15	10	19/25	703/900	38/45	703/180	133/100	133/16
5/12	Holmfirth	5/12	5/6	97/192	17/24	3/4	15/16	15/76	1	75/38	3/20	37/240	1/6	37/48	21/128	105/64
19/20	Dewsbury	19/90	19/45	1843/7200	323/900	19/50	19/40	1/10	38/75	1	19/250	703/9000	19/225	703/1800	133/1600	133/160
100/36	Macclesfield	25/9	50/9	485/144	85/18	5	25/4	25/19	20/3	250/19	1	37/36	10/9	185/36	35/32	175/16
100/37	Scotch (Glasgow and West of Scotland)	100/37	200/37	485/148	170/37	180/37	225/37	900/703	240/37	9000/703	36/37	1	40/37	5	315/296	1575/148
100/40	Irish	5/2	5	97/32	17/4	9/2	45/8	45/38	6	225/19	9/10	37/40	1	37/8	63/64	315/32
20/37	Dundee (and East of Scotland)	20/37	40/37	97/148	34/37	36/37	45/37	180/703	48/37	1800/703	36/185	1/5	8/37	1	63/296	315/148
1/0·3937	Splits per centimetre	160/63	320/63	194/63	272/63	32/7	40/7	160/133	128/21	1600/133	32/35	296/315	64/63	296/63	1	10
1/3·937	Splits per decimetre	16/63	32/63	97/315	136/315	16/35	4/7	16/133	64/105	160/133	16/175	148/1575	32/315	148/315	1/10	1

compared with No. 1 sett Huddersfield, while No. 1 sett or any other sett in these fourteen systems must be multiplied by the values in the first vertical column of fractions to find the equivalent Huddersfield sett. In other words, to convert from vertical names to horizontal names, multiply by conversion number; but to convert from horizontal names to vertical names, divide by conversion number.

It should be mentioned that the setts which are stated in hundreds—*e.g.* Macclesfield, Scotch, and Irish—are calculated literally by the number of hundreds, and not by the actual number. Thus, 900's, 1200's, 1600's, etc., would be calculated as 9, 12, 16, etc., because it is usual to write these setts as 9^{00}, 12^{00}, 16^{00}, etc.

The exact results for any conversion can be obtained only by some such method of calculation as those exemplified above, but approximate results can be found by graphical methods, and the latter, if deemed necessary, can be consulted for confirmation of the numerical processes. To supplement the above formulæ we introduce Fig. 28, which concerns the fifteen different methods explained in Tables III., IV., and V. In the figure each small square represents 1 sett or porter, and each large square = 10 sett or porter.

The numbers 1 to 15 on the right and on the top of each figure refer to the corresponding numbers in the tables, but in order to make references and comparisons as easy as possible, the name of the town or district appears above each line. The numbers on the left hand and on the bottom of each figure indicate the setts or porters.

A graphical chart as given in Fig. 28 is a quick and convenient means of comparing reed counts and ascertaining the nearest practicable count—*i.e.* whole number—in any required system, against a known count in any other system. For instance, reading upwards, the vertical

line 56 crosses the diagonal line marked Bolton at the horizontal line 46, showing that a 56 reed Bolton has 46 dents per inch. By inspection along the line 46, it is seen that this is equal to a 46 reed Huddersfield, an 83 reed Bradford, or a 92 reed Stockport. The chart is designed to meet all practical requirements and if any reeds over 100 are considered, the desired figure can be obtained by first halving the known reed, and doubling the number indicated on the chart.

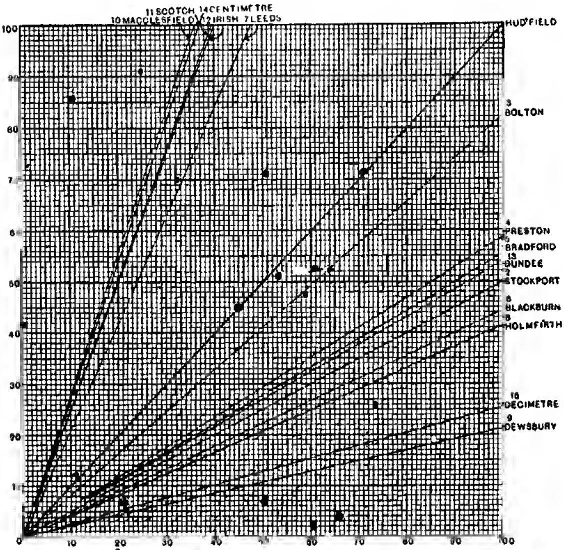


FIG. 28.—Chart for comparing setts and porters.

CHAPTER VII

GAUGES AND GLASSES FOR COUNTING REEDS AND HEALDS

REED GAUGES.—We might now describe the use of gauges such as those illustrated at S, T, U, and V in Figs. 1 and 3, those shown at W and X in Figs. 24 and 25, and others to be introduced shortly. A gauge for counting the setts of reeds and healds may be of any desired size, but in general it is most useful when it is a measure of the particular reed base for which it is to be employed. As a rule, comparatively large gauges are used for reeds and healds which are used for the weaving of coarse fabrics; while, on the other hand, much smaller gauges are desirable for the very fine fabrics. It must not be forgotten, however, that the possibility of making mistakes in counting decreases, as a rule, as the size of the gauge increases.

A simple method which is extensively employed, and one which enables the gauge in most cases to come within a reasonable size for pocket use, is to divide the reed base by the number of splits per beer or porter, and to use this result as the standard gauge for any particular district. Adopting this method, we find that the gauges for the fifteen different systems considered in this work will be as stated in Table VI.

TABLE VI.

1. Huddersfield		= 1 in. measure
2. Stockport		= 2 in. ,,
3. Bolton	$24\frac{1}{4}$ in. ÷ 20 splits	= 1·2125 in.
4. Preston	34 ,, ÷ 20 ,,	= 1·7 in.
5. Bradford	36 ,, ÷ 20 ,,	= 1·8 in.
6. Blackburn	45 ,, ÷ 20 ,,	= 2·25 in.
7. Leeds	9 ,, ÷ 19 ,,	= 0·4737 in.
8. Holmfirth	12 ,, ÷ 5 ,,	= 2·8 in.
9. Dewsbury	90 ,, ÷ 19 ,,	= 4·737 in.
10. Macclesfield . . .	36 ,, ÷ 100 ,,	= 0·36 in.
11. Scotch	37 ,, ÷ 100 ,,	= 0·37 in.
12. Irish	40 ,, ÷ 100 ,,	= 0·4 in.
13. Dundee	37 ,, ÷ 20 ,,	= 1·85 in.
14. Centimetre . . .	1 split per c/m.	= 0·39375 in.
15. Decimetre . . .	1 split per d/m.	= 3·9375 in.

It is only necessary to make suitably shaped articles in metal in which the distance between the extreme points represents any of the above-mentioned measurements. The method of ascertaining the sett of any reed is then quite simple, for the number of splits seen between the two extreme points of the gauge represents the sett of the reed. And, since the method of calculating the reed implies the use of two threads per split, it follows that, if two leaves are used, as is sometimes the case for the weaving of coarse fabrics, there should be twice as many healds or mails in the two leaves as there are splits in the reed, and hence each leaf should contain the same number of cords or mails between the two extreme points of the gauge as the reed contains splits between the same points. It is well known that when plain cloths contain a considerable number of threads per inch, it is necessary to use four leaves in the group; for such cases each leaf would contain half the number of mails between the gauge points as the reed does. Thus, suppose four leaves, containing respectively 11, 12, 7, and 5 mails per inch, were used for a cloth reeded two ends per split, the actual sett of that cloth would be 22, 24, 14, and 10. If, on

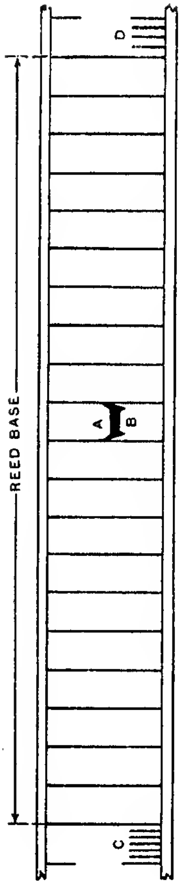


FIG. 29.—Fundamental reed and counting gauge.

the other hand, it were desirable to reed such cloths with four threads per split, the setts would still be 22, 24, 14, and 10 on the two-per-split basis, but the actual reeds used would be respectively 11, 12, 7, and 5. This phase of the subject will be discussed later. In the same way, the gauge W on the reed in Fig. 24 shows that the reed is 11 sett or 11 porter, whereas the gauge X in Fig. 25 indicates a 27 sett or porter reed. In both cases the upper measure is used, and the lower gauges may indicate the setts for other districts.

Summing up the method, it will be seen that where the beer, porter, or portie is represented by 20 splits, the gauge is made $\frac{1}{20}$th of the reed base, as shown clearly in Fig. 29. The main part of this figure represents the unit number of splits in the reed base—*i.e* 1 sett or 1 porter—because one split only appears between the extreme points of the upper measure A. The lower measure B, being narrower, would be used to measure reeds in which the reed base was proportionately narrower than that illustrated by the 20 splits. If the reed contained six splits as at C, the measure A would evidently cover the six, and would thus

indicate a 6 sett; while for a 4 sett the splits would be as at D.

Similarly, if the portie or beer is 19 splits, the gauge would be made $\frac{1}{19}$th of the reed base; finally, if the reed is reckoned by hundreds, the gauge should be $\frac{1}{100}$th of the reed base.

20 Splits per Beer or Porter:

x splits in gauge	represent	$20x$ splits in reed base	
1 split	,,	represents 20	,, ,,
30 splits	,,	represent 30 sett or "porter"	

19 Splits per Beer or Porter:

x splits in gauge	represent	$19x$ splits in reed base	
1 split	,,	represents 19	,, ,,
15 splits	,,	represent 15 sett or "porter"	

100 Splits per Unit:

x splits in gauge	represent	$100x$ splits in reed base	
1 split	,,	represents 100	,, ,,
14 splits	,,	represent 1400 or 14^{00} "sett"	

And so on for any other number of splits seen between the points of the gauge.

Counting Glass.—When the unit reed is reckoned by a hundred splits it is a common practice in many districts to employ what is known as a "glass" instead of a simple metal gauge or measure such as those illustrated at A and B, Fig. 29. The reason for discarding comparatively large gauges is the fact that it is impracticable as a rule to count a large number of fine threads, and even with a small number of threads, such as would come into the field of the lens, it is advisable to adopt a lens so as to magnify the threads, and so facilitate the operation of counting as well as to minimise mistakes. When counting with a small measure, care has naturally to be exercised, since a mistake of a fraction of a split is multiplied 100 times in the full width, which, of course, represents the actual quantity in the reed base.

An illustration of "glasses" such as are used in the

fine linen trade, and occasionally in the coarse linen trade, appears in the upper part of Fig. 30. In the large glass on the left, A is the base; B is the upper part or eye-piece, which contains the lens E; C is the part or back

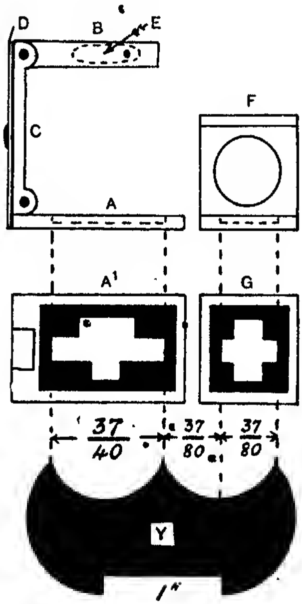


FIG. 30.—Counting glasses and gauge.

to which both A and B are hinged as shown; while D is a broad flat spring riveted by two rivets at the middle to C, and hence forms a spring for both A and B.

The plan of the base A is shown at A¹, the white part in the centre representing the portion which is cut

out to the desired measurements to expose the threads to view. Then when the base A is placed upon a reed with the parts in the position illustrated at A, B, C, and D, it follows that the splits of the reed can be counted by looking through the lens E. Such glasses, however, are perhaps more extensively used for counting the picks or shots, particularly where the weft is white, or of any light shade which can be seen clearly. For fine black or dark wefts, such as are common in the fancy worsted and silk trades, and for those fabrics where the weave makes it difficult to see the weft, or even to count the repeats of the weave, it is a common practice to count the weft in the loom by introducing a fine heald twine or similar thread into the shed, say, about $\frac{1}{2}$ in. or so, then to count what number of picks should be in the cloth, and to introduce the other end of the heald twine in the same plane. This method is, obviously, impossible when the cloth is out of the loom or for any portion of the cloth which has been woven already.

The parts F and G, Fig. 30, are respectively the back and base of a smaller glass, which is constructed somewhat similarly to the larger example. The lower figure or measure Y is the same as that illustrated by the letter U in Fig. 3 and the letter W in Fig. 24. This particular gauge is made in two parts, each of which is naturally $\frac{37}{40}$ of an inch, since the full gauge is $\frac{37}{20}$ of an inch, or 1·85 in. The single gauge of the bottom is 1 in. in width, because it is usual to count the shots per inch, and not shots per measure, in many districts.

The dotted projections from the three upper points of the measure Y, and the projection from the middle of the right-hand section, show clearly that the measurement of the horizontal opening in the base A^1 is also $\frac{37}{40}$ of an inch, while the horizontal opening in the base G is $\frac{37}{80}$ of an inch.

In the bases of many glasses there are only three sizes cut; thus, the cut-out portion may be as illustrated at A, Fig. 31, in which case the three measurements may be those indicated—viz., $\frac{37}{40}$, $\frac{37}{80}$, $\frac{37}{200}$,—or they may be any other suitable sizes to satisfy the requirements of the district. There is little danger of taking the wrong gauge in such a glass, because there is such a great difference between the three measurements.

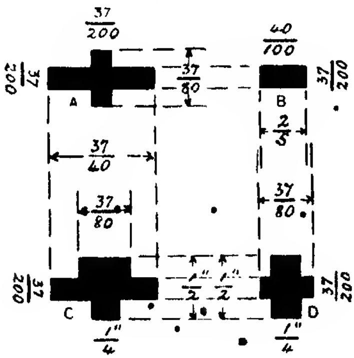


FIG. 31.—Counting glasses and gauge.

The aperture may be even simpler, and consist only of a rectangle, such as that shown at B, Fig. 31; for certain districts these two measurements may be quite sufficient. Thus, the gauge $\frac{40}{100}$, or $\frac{2}{5}$ of an inch, would serve to count the Irish reeds, which are reckoned by the number of hundreds of splits in 40 in., while the $\frac{37}{200}$ part could be used for what is commonly called "the picks per glass."

If, however, a more composite glass is desired, several gauges may be cut into the base, as illustrated at A[1],

Fig. 30. These measurements are reproduced at C, Fig. 31, and are of the values $\frac{37}{40}$, $\frac{37}{80}$, $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{37}{200}$ of an inch. When using such a glass, however, great care has to be taken to select the proper one, and to facilitate this selection it is advisable to place distinguishing marks on, say, two of the gauges for guidance during the operation of counting. The base-plate G, Fig. 30, is also reproduced in Fig. 31 at D. The simple type of base provides, in general, all that is necessary.

Gauge glasses as illustrated in Fig. 30, or similar glasses, are used, as already mentioned, to count the picks of weft in the loom; they are also used to count the threads and picks of the cloth in the finished state, or in any other stage. It is obvious, however, that the numbers in the cloth out of the loom will, in general, differ from those in the cloth during weaving, and if any connection between the two is desirable, the necessary allowances must be made. It is not always an easy matter to find this correct allowance—it may be found with a high degree of accuracy in some cloths,—but if the relation between the cloth width and the reed width (the space occupied by the warp threads in the loom) can be found, it is not difficult to find what the sett or porter was in the loom, and what particular reed could be employed with that estimated sett of the healds or cambs. The method adopted is as follows: Take the reed gauge which is used in the district, and place it on the cloth. Count the total number of threads of warp contained between the two extreme points of the gauge or measure, and divide this number by 2, the accepted number of threads per split for plain cloth and for the denomination of the sett. This will clearly give the sett or porter of the cloth in that stage on the basis of two threads per split. Then reduce the sett thus found by the percentage of shrinkage which has taken place from the healds and reed to the cloth.

Example: Suppose a 36-in. finished cloth contains 89 threads between the two points of any gauge, and suppose, further, that the shrinkage from the reed width to the cloth width is 4 in.; what sett or porter of healds should be used on the two-threads-per-split basis?

$$\frac{89 \text{ threads in measure}}{2 \text{ threads per split}} = 44\tfrac{1}{2} \text{ sett in the finished cloth.}$$

$$\frac{44\tfrac{1}{2} \text{ sett} \times 36 \text{ in. cloth}}{40 \text{ in. reed width}} = \frac{80{\cdot}1}{2}$$

$$= 40{\cdot}05 \text{ or } 40 \text{ sett in the reed.}$$

If the shrinkage happens to be given in terms of percentage—*e.g.* the above particulars with 10% shrinkage from reed width to cloth width,—then—

$$\frac{89}{2} \times \frac{90\%}{100\%} = 40{\cdot}05 \text{ or } 40 \text{ sett in the reed as before.}$$

Finally, if the number of threads per inch of the cloth is given, this number may be converted immediately to any required sett or porter by multiplying the number of threads per inch by the size of the gauge, dividing by two threads per split, and multiplying by the ratio of the cloth width to the reed width. Hence, the complete formula from the number of threads per inch in the finished state to the required sett or porter of the healds for the loom is as under—

$$\frac{\text{Threads per inch} \times \text{size of gauge} \times \text{cloth width}}{2 \text{ threads per split} \times \text{reed width}}$$
$$= \text{sett of healds.}$$

If, for any hypothetical case, the shrinkage is not to be considered, then—

$$\frac{\text{Threads per inch} \times \text{size of gauge}}{2 \text{ threads per split}} = \text{sett or porter.}$$

Should it happen that no such gauge or measure is handy

or available, the same result could be obtained as under—

$$\frac{\text{Threads per inch} \times \text{width of reed base}}{2 \text{ threads per split} \times \text{splits per beer or porter}}$$
$$= \text{sett or porter,}$$

and from this the actual sett of the healds can be obtained by multiplying by the ratio—

$$\frac{\text{Cloth width}}{\text{Reed width.}}$$

It need hardly be said that correct results could be got by other arbitrary methods, but the above is perhaps the most rational way. If from any cause it is desirable to reed the warp differently from two threads per split—a procedure which is not at all uncommon—very little difficulty is introduced.

Suppose, for example, there are 72 threads between the extreme points of the gauge, and that the degree of shrinkage is neglected for the sake of simplicity, we have—

$$\frac{72 \text{ threads}}{2 \text{ threads per split}}$$
$$= 36 \text{ sett reed to use, and } 36 \text{ sett cloth.}$$

$$\frac{72 \text{ threads}}{3 \text{ threads per split}}$$
$$= 24 \text{ sett reed to use, and } 36 \text{ sett cloth.}$$

$$\frac{72 \text{ threads}}{4 \text{ threads per split}}$$
$$= 18 \text{ sett reed to use, and } 36 \text{ sett cloth.}$$

And so on. The actual sett in the healds, or the number of threads in a given space, remains constant for any given example, and so does the sett or denomination of the cloth, when it is reckoned on the two-threads-per-split basis. The different methods of reeding are supposed to be adopted for some particular practical reason in the weaving department. If one thread per split had been

used in the above case, it is evident that the sett of the cloth would still be 36, but a 72 sett reed would be used in conjunction with 36 sett healds.

In some districts the denomination of the cloth, so far as the sett or porter is concerned, is influenced by the weave as well as by the number of threads in each eye or mail. In other words, the number of threads per split increases with the number of leaves employed, or, rather, with the number of threads in one repeat of the weave, and is doubled when two threads are drawn through each eye of the mail. This applies so far as calculations are concerned, but departures from the actual calculation number may be and are made for specific purposes in the weaving operation. The following particulars will explain the practice:—

Plain weave.......... $^{1}{}_{1}$	Single warp	2 single threads per split
,, ... $^{1}{}_{1}$	Double ,,	4 ,, ,,
3-leaf twill .... $^{2}{}_{1}$,, ... $^{1}{}_{2}$	Single ,,	3 ,, ,,
3-leaf twill .... $^{2}{}_{1}$,, ... $^{1}{}_{2}$	Double ,,	6 ,, ,,
4-leaf twill .... $^{3}{}_{1}$,, ... $^{1}{}_{3}$	Single ,,	4 ,, ,,
4-leaf twill .... $^{3}{}_{1}$,, ... $^{1}{}_{3}$	Double ,,	8 ,, ,,

To take a concrete case of a reed having six splits per inch, the number of threads per inch in the reed for the above six cases would be 12, 24, 18, 36, 24, and 48. This method, however, is not general.

In many instances the reeding is irregular, and in some cases a number of splits are unoccupied. Even in these cases a very similar process can be adopted. Say, for example, a 36 sett cloth requires the reeding to be as follows: 4, 2, 2, 6, 2, 2; what reed should be used with the 36 sett healds?

Here we have $4 + 2 + 2 + 6 + 2 + 2 = 18$ threads in 6 splits, or $18 \div 6 =$ an average of 3 threads per split; hence—

$$\frac{36 \text{ sett} \times 2 \text{ threads per split}}{3 \text{ threads per split}} = \frac{72}{3}$$

$= 24$ sett reed to be used.

Again, suppose the reeding is to be 3 and 2 alternately. This is an average of $2\frac{1}{2}$ threads per split; hence—

$$\frac{36 \text{ sett} \times 2 \text{ threads per split}}{2\frac{1}{2} \text{ threads per split}} = \frac{36 \times 2 \times 2}{5}$$

$= 28{\cdot}8$ sett to be used.

CHAPTER VIII

VARIOUS KINDS OF REEDS AND HOOKS

We shall conclude this work with a few illustrations of different kinds of reeds used both in the preparation of the warp threads for the loom and for the actual weaving process. We shall also illustrate a few different kinds of

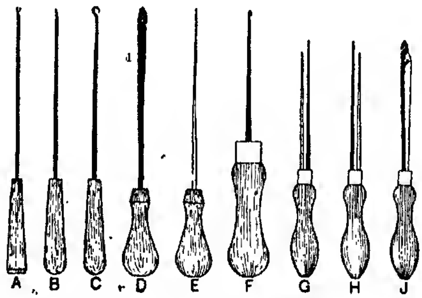


Fig. 32.—Single and double drawing-in hooks.

hooks which are used for drawing the warp threads through the mails of the heald and between the wires of the reed.

Nine views of draw hooks are shown in Fig. 32. A is a hook for cotton, worsted, or silk yarns; B is a hook for comparatively thick yarns, such as woollen and the smaller-sized jute yarns; C is a hook for thick jute yarns or thick woollen yarns; D and E are two views of a hook for drawing fine

threads, such as cotton, through knitted eyes; F is a hook for drawing cords through comberboards; G, H, and J are different views of a double hook for drawing two threads at a time through two mails on different leaves. In the latter view the longer hook is shown in solid black, while for distinction only the shorter hook is stippled. This double hook may be, and is, used for drawing warps through two or four leaves for plain and twilled work, for huckabacks, dice patterns, and the like. The drawer-in inserts the short hook through an eye on No. 1 leaf, and the long hook through an eye on No. 2 leaf, if two leaves only are used. If the draft is 1, 3, 2, 4 on four leaves, then the short hook draws through eyes on No. 1 leaf, and the long hook draws through eyes on No. 3 leaf, after which the short hook enters an eye on No. 2 leaf, and the long hook enters an eye on No. 4 leaf.

The "giver-in" or "reacher-in" selects two threads at a time—one between the first and second fingers, and another between the thumb and the first finger. She pushes the latter thread between the two hooks, and places the former to the right outside the shorter hook, and then draws her hand a little to the left. This causes the two threads to engage with the two hooks, and the drawer-in withdraws the hooks from the eyes, and thus secures the two threads in their proper eyes as stated above.

Fig. 33 illustrates several kinds of reed hooks. A and B are two views of a hook for use in conjunction with fine reeds; C and D are two views of a heavier hook for comparatively heavy yarns and coarse reeds; E and F are two views of a large reed hook for very heavy yarns and coarse reeds; G and H are two hooks used extensively in the United States of America (they are curved as shown to make the work easier, and the handles are simply discs of leather); J, K, L, and M are four views of a special hook

patented in 1906 by Messrs. Felton and Guilleaume, Germany (the hook is designed to be used in conjunction

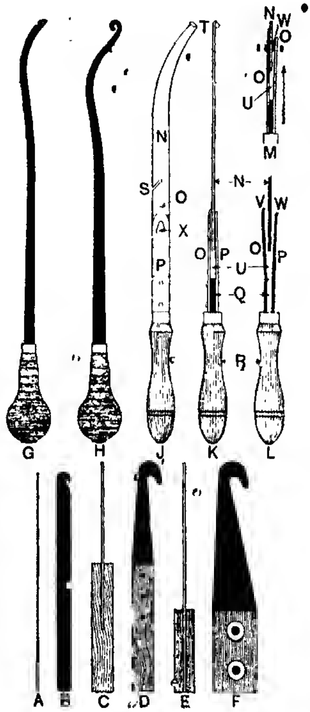


FIG. 33.—Reeding-in hooks.

with the double draw hook illustrated at G, H, and J in Fig. 32). The complete hook consists of two parts—the actual hook or blade N and the two spring clasps O and P,

which are secured to a tongue Q; the three parts O, P, and Q are fixed to the handle R. The hook or blade N is inserted between two wires of the reed, and is not supposed to leave the reed until all the threads of the warp are entered. The slot S is for drawing the threads through the reed, while the hooked end T is intended to prevent the blade from slipping out accidentally.

After two threads of the warp have been drawn through the healds by the right hand, they are caught by the hook S of the blade N and drawn through the reed by the left hand. When the hook S is engaging with the two threads, the reed wire is enclosed in the gap U below the bottom end of the blade N, and as the blade is drawn downwards it is pulled to the right, so that the reed wire gets between the blade N and the left-hand spring O, and ultimately leaves at the point V in illustration L.

When the blade N is pushed upwards, the next reed wire W on the right enters as shown in illustration M, and finally enters the gap O. Hence, as the operation proceeds, the left-hand reed wire emerges on the left hand of the blade N as the latter moves downwards, while the right-hand reed wire enters on the right of the blade N when the latter is moving upwards.

A later improvement consists in having another hook S at the other side of the blade N, and the blade made straight, so that the reeding may also be done from right to left. In another case diamond-shaped parts instead of pear-shaped parts X, near the bottom of the blade N, are used with suitable holes in the springs O and P to form the connection between the three parts, and to hold the blade N firmly during the operation of reeding.

The various reeds are illustrated in Figs. 34, 35 and 36 In Fig. 34, A, B, C, and D, are four views of a gauze reed. The few reed wires on the left of A represent a 600's reed on 37 in. scale, while those wires on the right represent

a 300's reed on the same scale. (Note: Block is one-fourth of the original.)

Each alternate reed wire E in each section is full length, while between each pair of long wires is a half-reed wire C (see end views). It will be known that these reeds are used in the manufacture of Madras muslins, and that the reed in question occupies a position between an ordinary reed and a "tug" reed. The latter reed is used to move each standard thread from one side of its split to the other, and thus facilitate the movements of the crossing threads which are drawn through the eyes of the half reed and through the splits of the ordinary reed, but not through the tug reed.

In olden times the splits of ordinary reeds were formed by split cane, and one of these is shown at F. The remaining four, lettered G, H, J, and K, are metal wires, and have been taken respectively from a fine reed, a medium reed, a reed used for hose-pipe weaving, and from a reed used for Brussels-carpet weaving.

An ondule reed is illustrated at L, and this, in addition to fulfilling the ordinary functions of a reed, rises and falls gradually during the weaving operation. The sett of the fabric is thus continually altered between two fixed limits, such limits being obviously determined by the angles of the wires. The result in the cloth is a vertical ogee pattern. Reeds have been made to produce somewhat similar variations in the weft, but in this case it is clear that great difficulties are encountered. A few vertical splits are drawn on the extreme right hand of illustration L to show a sett of the reed which is equivalent to that of the ondule reed midway between the top and bottom boards.

A reed used for fancy gauze weaving is illustrated at M. On the left hand there are four reed wires which form three splits from board to board, while the next three wires extend only about three-quarters down. The crossing

thread or net thread works from side to side of the three-quarter-length wires when near the bottom of the reed; it can thus cross two splitfuls of warp. On the right-hand

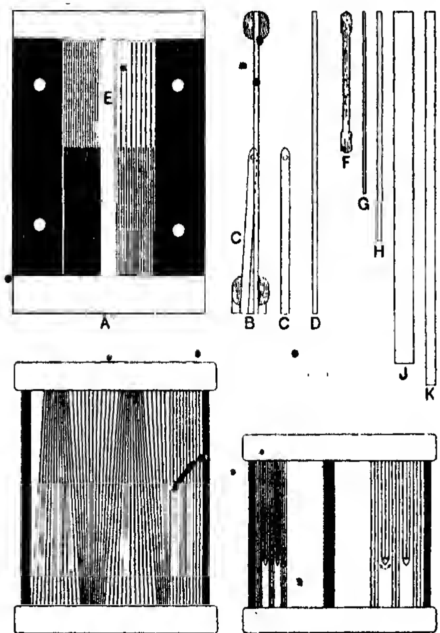


FIG. 34.—Weaving reeds of different kinds.

side of the same reed is a coarser part in which there are two full-length splits, and a similar arrangement of splits for the crossing thread to extend as indicated by the arrow. The ends of these shorter reed wires are soldered together.

Near the middle of this reed M are a few wires to represent the finest reed which the writer has seen; this reed contained 60 splits in one inch.

Fig. 35 shows a few types of reeds, etc., which are used for preparing the warp threads for dressing or beaming. A deep reed used for beaming machines is shown at A; when this reed is arranged to be adjusted vertically, either by screws or otherwise, it is clear that the space occupied by the threads can be slightly altered, according to the angle of reed wires, so that the edges near the flanges of the beam may be made the same diameter and of the same solidity as the remaining parts of the beam. It will, of course, be understood that the two dotted lines represent a space between the centre of the reed and the edge, and that the angles of the wires approach nearer and nearer to 90° to the horizontal as the centre of the reed is reached, as represented by the five vertical wires.

An "angle reed" is shown at B, and these are used extensively in conjunction with a rod for the purpose of preventing the warp threads, when reeded two per split, from running in pairs on to the drying cylinders of the dressing machine. Two splitfuls are shown, one thread from each splitful in a higher plane than its neighbour; the distance between the two layers of threads is caused by the insertion of a rod; the rod thus separates each pair of threads and causes them to occupy, not only different horizontal planes, but also different vertical planes, as demonstrated in the drawing.

A shallow reed or comb is shown at C, and such combs may be made either with vertical wires all along as indicated on the left, or at an angle near the ends as shown on the right. In the latter case the arrangement would be very similar to that shown at both ends of the reed A. Such reeds or combs are used largely for guiding the warp threads on to the beam during dressing, slashing, or

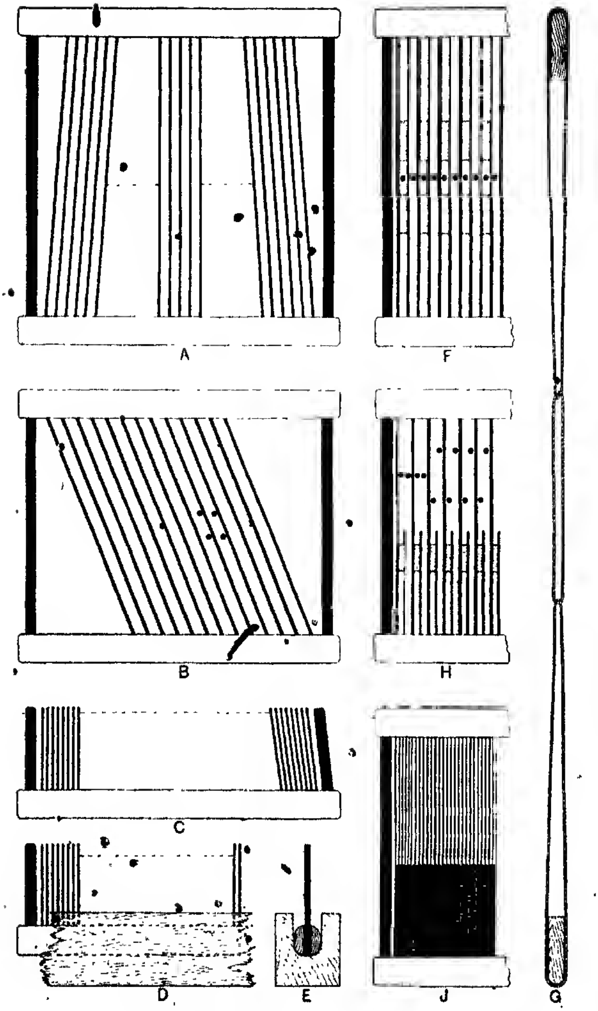


Fig. 35.—Beaming reeds and leasing reeds and heald.

beaming operations. The reed is supported somewhat as shown in front and end elevations at D and E, and a cap is often used to cover the points of the wires and thus prevent the threads from being accidentally withdrawn from their proper splits. Clasp rods are often used at the ends of such warps instead of taking a thread-by-thread or drawer's lease.

A common type of leasing reed is shown at F. One thread is passed through the full-length split, and the next thread through the eye formed by the soldered blocks indicated by stippling. Ten threads are shown at the centre, the approximate position occupied by the threads when they are running through the reed on to the weaver's or dresser's beam. To form a lease, the reed is raised, which would clearly carry upwards all those threads, the odd-numbered ones, in the eyes, and allow all the even-numbered threads in the full splits to pass to the bottom of the splits, and so effect the first desired separation of the threads. Afterwards the reed is forced downwards, and this action causes the odd-numbered threads in the eyes to pass to the lowest position, while at the same time the even-numbered threads in the full splits pass to the top to form the second lease.

A leasing heald for the same purpose is illustrated at G. One thread is passed through the long eye of the heald, and the next thread goes between two healds. Thus all odd-numbered threads are through the eyes of the heald, while all even-numbered threads appear between the eyes. This type of leasing heald may be used for a large number of threads, but its use is confined to dry beaming.

For fine work, or, rather, where a large number of threads are to be controlled, the reed shown at F is unsuitable; reeds known as "hook-reeds" and illustrated at H and J are employed in such cases for the same function. H is a comparatively coarse reed, and has been

made so for the purpose of showing the construction and operation of the reed quite clearly. The long wires are thicker than the short or half wires, and the two are soldered together near the top of the latter to form a hook as demonstrated. In the first two splitfuls the threads are level, but it is usual to insert a thick rod between each pair of threads so that the threads will occupy two planes about 1½ in. apart, as illustrated in the four splits on the right.

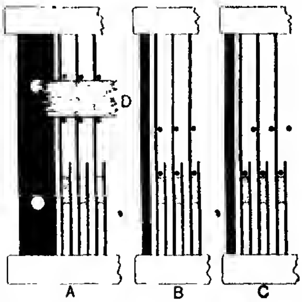


FIG. 36.—Beaming reeds and leasing reeds and heald.

The first few splits in the reed J are a little finer than the remainder, and are made with heavy and light wires alternately. Both kinds of wires for the coarser part are, however, the same thickness in this section.

The method of operating the reed is as follows: At the conclusion of a warp, one lease band is placed between the threads, when the separation is as shown at H, Fig. 35. Part of the rod D is shown in Fig. 36, and this rod occupies a position behind the reed—that is, on the starching-roller side of the machine. The lease cord is placed in the same opening, but on the other side of the reed, nearer the drying cylinders. The lease cord is moved a short distance

from the reed to enable the second lease to be made freely.

To form the second lease the hook reed is moved towards the right until all the threads occupy the same vertical plane, as demonstrated at A, Fig. 36. Then the reed is raised until the lower group of threads, sliding against the long wires, enter the hooks between the long and short wires. The position of the threads will then be as exemplified at B. (In reality the reed occupies a higher plane when the threads are in the hooks, but all the reeds in Fig. 36 are drawn in the same horizontal plane.)

While the threads are in the position indicated at B, Fig. 36, the hook reed is moved to the left; those threads in the hooks are retained there, and move with the reed to the left; but the upper set would be made to occupy a position on the right as shown at C. If now the reed is raised still further, it is clear that the upper set of threads will slide to the bottom of the reed, or, rather, the lower set in the hooks will be carried past them as the reed is being moved upwards. The two sets of threads will thus be placed in the proper position for inserting the second lease band in front of the reed. The machine is then started until both lease cords reach the beaming reed, when the lease has to be transferred to the beam side. The hook reed and rod have meantime been placed in position for dressing another cut or piece of yarn. It will thus be seen that it is unnecessary to remove the rod D.

Reeds for the loom are also made in which the wires are spaced irregularly. Thus a certain section near the middle, or some other place or places, may be of a much finer sett than the remainder of the reed. Again, a reed may be coarse or a low sett near the middle, and gradually assume a finer sett as the ends of the reed are approached, or it

may be of a fine sett near the middle, and gradually get coarser towards one or both ends.

Finally, reeds have been made with alternate wires set obliquely, somewhat as illustrated in Fig. 37. The reed is raised and lowered so that alternate picks may be beaten up at A and B respectively. It will thus be seen that half the total number of wires are in operation each time. Several advantages are claimed—*e.g.* less crowding, less

FIG. 37.—Reed with oblique wires.

work for reed wires, clearer opening of shed on account of threads, or rather wires, being in two rows, less friction on the threads, fewer breakages, fewer stoppages, less reed marking, and a tendency in some fabrics to prevent looping. Against these important advantages which the above reeds are said to possess there is the disadvantage of having to move the reed every pick, the introduction of the mechanism for performing these up-and-down movements, and the probability of a less stable reed.

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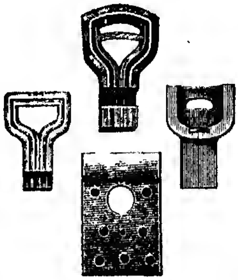

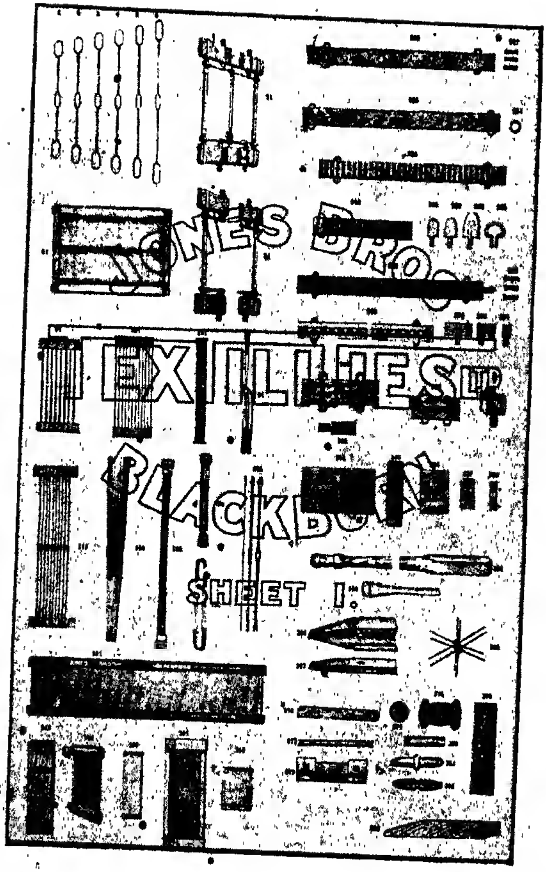
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